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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

SEPTEMBER 4-22.
Fifth German Foundry Exhibition at Düsseldorf.

SEPTEMBER 9-12.
Institute of Metals:—Annual Autumn Meeting in Düsseldorf.

SEPTEMBER 10-13.
Iron and Steel Institute:—Autumn meeting at Newcastle-upon-Tyne.

SEPTEMBER 12-28.
Shipping, Engineering and Machinery Exhibition at Olympia, London.

Activity in the Iron and Steel Trade.

It is matter for some surprise that there has been so little Press comment on the personnel of the new Government Committee to investigate the condition of the iron and steel industries. This Committee, like the inquiry into the circumstances of the cotton industry, will function as a sub-committee of the Committee of Civil Research. Possibly this lack of interest arises from the fact that many people think no further inquiry is necessary. There have in recent years been a number of elaborate inquiries by various Government Committees. The most important of these was the Committee on the Engineering Industry, which reported shortly after the war, and more recently there has been the Balfour Committee, which devoted more than a little attention to the iron and steel trade. It is admittedly doubtful whether a committee appointed by the present Government would be prepared to contemplate any measure of protection for the trade, but if a case were to be made out for protection *versus* extinction, we do not think that the Government would be so inflexibly minded as to refuse to listen. The actual personnel of the committee is disappointing in that none of its members has had any first-hand experience of the trade. They are, however, individually, very able men. Lord Sankey, the Lord Chancellor, was chairman of the Coal Industry Commission in 1919, and as such he took a large share in preparing the famous Sankey report, a report that advocated measures so drastic that it has never been acted upon. From this we may reasonably infer that the present report will not lack courage. Mr. A. V. Alexander, the First Lord of the Admiralty, is well known as the man behind the Co-operative Movement, and as such has had a wide experience of wholesale and retail trading in perishable commodities. Mr. C. T. Cramp, who is, of course, general secretary of the National Union of Railwaymen, can doubtless be relied upon to represent the interests of that most important group of users, the railways. The financial aspect of the problems at issue will be safe in the hands of Sir William Plender, who is a distinguished chartered accountant. The only direct metallurgical experience on the Committee is that of Sir Cecil Budd, chiefly known for his non-ferrous interests. He is an ex-chairman of the London Metal Exchange and managing director of the British Metal Corporation. Although the foundry trade is not directly interested in the work or the outcome of such a Committee, we have never disguised the fact that it is bound to be profoundly affected by the development of the iron and steel trade as a whole, and for this reason we must watch the Committee with attention. In the meantime, the trade itself has taken an interesting forward step. The National Federation of Iron and Steel Manufacturers has formed a small independent company for the purpose of carrying out certain co-operative ventures which are in the interests of the members of the Federation, but which are outside the scope of a trade association as ordinarily constituted. While there is, of course, no direct relation or connection between these two items, it is interesting and encouraging to learn of activity directed to the iron and steel trade, both from within and without, activity of which we in the foundry trade will inevitably feel the repercussions sooner or later.

A Set-back to Welding as a Competitor to Castings.

The British Engine, Boiler and Electrical Insurance Company, Limited, in their Technical Report* for 1928, just issued, details a long research it has carried into the use of welding for pressure vessels. This is of special interest to the foundry metallurgist and engineer, because of the conclusions reached after really extensive investigations. We specially commend a perusal of this works to the large electrical engineering firms who recently have evinced a strong *penchant* for built-up structures in place of castings. The conclusions reached are noted below.

"It is not denied that many most excellent welds are made, and indeed a number has been examined during the course of the inquiry, but the quality of the ordinary commercial weld falls far short of the ideal, while many welds are definitely bad. Regulations are required if the legitimate development of welding is not to be retarded, and until such regulations are framed and enforced it is inevitable that trouble and disappointment will be the lot of makers and purchasers alike."

We anticipate that those who have devoted so much energy and skill to the perfecting of welding will reply that the art is still in its infancy or that there is still a deficiency of skilled operators. But in the case of the first excuse we insist that the same conditions apply with equal force to the foundry industry, as the last five years has indicated greater potentialities for cast iron than was ever dreamt of it prior to that date. As for the second plea, the same condition also applies, but with the proviso that the mechanisation of the industry is translating much of the work from the category of "skilled" to "semi-skilled" and even "unskilled."

Foundrymen welcome the welder as an adjunct to their craft. The tools of the welder have been largely adopted by the steel founder for the removal of runners and risers, whilst every branch of the foundry industry has made use of the welder's art for remedying unimportant surface defects.

But this essentially auxiliary trade has recently, under the ægis of the electrical concerns, been revamped into the nucleus of a competitive industry, and as such it must be

(*Continued on page* 186.)

* Price 7s. 6d., from 24, Fennel Street, Manchester.

XUM

Crystals and Strength of Alloys.

GRAIN STRUCTURE AND FRACTURE.

"Crystalline Grains in Castings"*—a Paper submitted to the International Foundry Congress—was seized upon by the foundry metallurgist to clear up a few common misconceptions, and to stress the necessity of both the practical foundryman and the engineer holding clearer views as to its effect and utilisation for the production of definite and utilisable properties. The discussion was opened by the President (Mr. Wesley Lambert), who emphasised that the subject of the crystalline grain structure of castings was of paramount importance. Foundrymen did not like to talk much about the crystalline structure of a metal, because the reference to it always gave the engineer a wrong impression, but all metals which had been melted and founded either in the form of ingots or castings exhibited a decided crystalline structure. Although he had spoken of "crystalline structure," he rather favoured the description "grain structure." Upon examining the fracture of a casting, one was not necessarily looking at crystals, but at grains of a crystalline formation. The question of whether a casting was weak or strong was determined not so much by the size or order of the grain structure as by the inherent properties of the grain, the mechanical dovetailing effect of one grain with another, and the cementing together of individual grains. Included in the inherent properties of the grain was its plasticity—is it likely to deform much under stress, or is it of a brittle character? The crystalline grain structure of metals has less relation to the tensile strength or resistance to fracture under shock than many engineers think it has. One can obtain excellent test results from a metal having a crystalline grain structure of fairly considerable size. There was a good deal of talk, he continued, about metals becoming crystalline through fatigue, but one could not make crystal grains grow by fatigue stresses. Could one imagine anything more ridiculous than to suggest that by stressing a metal one could make the crystal grains grow; surely as the result of repeated stressing the grains would be much more likely to become smaller by attrition. He emphasised the point that the crystal grains found on visual examination of fatigue ruptures pre-existed in the metal; one could not enlarge crystal grains except by thermal treatment, and the fact that the crystal grains were exposed in a fracture was no indication that the metal was necessarily weak. In a manganese bronze having a tensile strength of 40 to 45 tons it was not uncommon to find fairly large crystalline grains. By thermal treatment of a metal with a structure such as that exhibited in Fig. 3 of the Paper, for instance, it was possible to make one grain absorb another. This statement does not mean necessarily that the larger grains will absorb the adjacent smaller grains. He had succeeded in growing some very large grains as a result of thermal treatment.

Star-shaped Crystals and Bearing Metals.

Mr. A. H. Mundey said the author of the Paper had put forward many important points concerning the physical properties of metals, which points ought to be more sympathetically considered and more thoroughly understood by foundrymen than they actually were. There was a great tendency to decide that a material was rotten because it showed a highly crystalline structure, and it was not fully realised that the crystals were always there but were not always visible. Referring to the tests, described by the President, on gun steel, he said that the effect of the final test was practically the effect of a notched bar test, in which the stresses were concentrated and a partial shear was obtained. In that particular case, because the stresses were concentrated at one point, there were no slip bands and there was no movement of the crystals; the fracture occurred in the intercrystalline spaces. It was dependent very largely upon the character of the crystals, their physical properties, and the particular kind of interlocking which existed.

Referring to the star-shaped crystals, he said that in connection with the white metals, metallurgists were careful to arrange that those very crystals, instead of being a source of trouble and anxiety, were enlisted into engineering service, and that provided an interesting example of the manner in which the metallurgist was trying to help the foundryman. In the case of a white bearing metal, consisting of tin, copper and antimony, and maybe a little lead, if there were more than 7 per cent. of antimony present, cuboid crystals of antimony would separate out; these would segregate into groups, unevenly distributed, and if they were very large there was a tendency for them to break around the crystals and exhibit a large crystalline structure. When copper was present in the correct and well-balanced proportion, however, the copper separated out first as a copper-tin crystal, or maybe even as a copper-antimony crystal with a copper-tin crystal encasing it and isomorphous with it, and distributed itself throughout the freezing mass in dendritic crystals—needle-shaped and star-shaped—so that it formed a nice network on which the cuboid crystals, which separated out at a little lower temperature, attached themselves. Thus, if one could obtain a section through some of these white bearing metals as they were freezing, it would look something like a cobweb, on a spring morning, dotted with little diamonds of dew. The attachment of the cuboid crystals of antimony to the copper-tin and copper-antimony network prevented the cuboid crystals becoming segregated. The fibrous structures of which one heard so much did not really exist in metals. The structures consisted of crystals, and the ends which were pulled out and made to look like silky fibres were really the ends of crystals which had smoothed over one another.

False and Real Structure of Wrought Iron.

The President, supplementing his previous remarks and those of Mr. Mundey as to the existence of the crystal grain structure of metals, suggested a simple test which may be carried out on a bar of good wrought iron, of, say, 1 in. diameter. If one nicked round such a bar and struck it sharply with a hammer in such a manner as to jar off the end of the rod, the crystalline grain structure of the material would be observable, although the material was recognised as being good wrought iron. One could then nick the bar a little further along its length and hammer it over until it fractured in such a manner as to show a beautiful silky fibrous fracture.

Continuing, the President recalled a fatal accident which had occurred some years ago as the result of the breaking of a link of a chain. It appeared from the fracture that the metal was very coarsely crystalline. The coroner, at the subsequent inquest, examined the broken link and inquired whether it was considered to be a good iron; the reply was that there was every reason to believe that it was quite normal. The link was tested; full specification test results were obtained from it. A lecturette was then delivered to the coroner on the production of fractures of different appearance from the same bar of metal. The coroner asked whether it would be possible, if he marked one of the links, to reproduce the same fracture as that of the link which had broken. It was pointed out to him that this would be somewhat difficult, but not impossible. After some little trouble it was found possible to break another link of the chain and produce a similar crystalline fracture. He mentioned this experience in order to emphasise that practically all metals were crystalline in structure, and that the appearance of a fracture was dependent upon the manner in which that fracture was effected.

Strength with Grain-Size Reduction.

Mr. T. H. Turner said that in considering the effect of crystallisation in castings, it was well to point out that it was possible in certain cases to reduce the crystal grain size. This had been done especially in the 13 per cent. silicon alloy of aluminium, by an addition of elements causing what was termed "modification." Cast iron was, to a smaller extent, being similarly treated. Foundrymen, therefore, had an important and novel means of decreasing the grain size of their alloys, and the liability to fracture under shock, of the type so ably described by the President, was much decreased when the grain size was reduced. It was probable that the modification of other casting alloys would be everyday practice in the future.

* See our issues of August 15 and 22.

Influence of Graphitisation of Cast Iron.

Professor Diepschlag, in reply to Dr. Norbury's contribution on his Paper, presented to the recent International Congress, writes that, considering the relations between the structure of a section of a grey iron alloy and its mechanical properties, it must be borne in mind that one sees only the surface of the picture, or a small area of the test-bar. That is only a small part of the whole material, and the conclusion may not be quite true in all cases that the structure seen in the section must necessarily represent the whole specimen. The average results of a certain number of tests only give the correct approximation of these relations.

He thought it quite probable that with a certain degree of distribution and refinement of the graphite—especially graphite in eutectic form—the mechanical properties of the metallic crystalline bodies prevail over those of the graphite, and give the alloy its character. It is very useful that Dr. Norbury has ascertained the limit of the prevailing influence of the graphite, because he supposed that just in this region one would find the grey-iron alloys with both the best mechanical properties and good pouring qualities.

A Link with the Past.—Recently there visited Falkirk, quietly and unostentatiously, a gentleman of a name and family very distinguished in Scottish industrial history. He was Mr. Arthur W. Roebuck, great-great-grandson of Dr. Roebuck, one of the founders of Carron Iron Works, and who in his day was an outstanding figure among the pioneers of what has become known as the industrial revolution. Mr. Roebuck is one of the leaders of the single-tax and Free Trade movement in Canada. He is a barrister by profession, and practises at the Bar of Ontario, Toronto, Canada. Mr. Roebuck was recently in Edinburgh as a Canadian delegate at an International Conference on Land Values Taxation, and took the opportunity of visiting the place in Stirlingshire and West Lothian with which the name of Roebuck was so intimately associated. Mr. Roebuck was officially received by Provost Smith, of Falkirk, who subsequently accompanied him to Carron Iron Works, where he was warmly welcomed by Mr. George Pate, O.B.E., the general manager. He was shown all over the extensive works and entertained to luncheon by the firm. Later Mr. Roebuck was the guest of Mr. H. M. Cadell, of Grange, Linlithgow, a descendant of one of Dr. Roebuck's original partners, and the historian of Carron Iron Works. Together they paid a visit to Kinniel House, Bo'ness, where Dr. Roebuck resided, and also to Carriden Parish Churchyard, where he is buried. Mr. Roebuck has arranged for the renovation of his famous ancestor's tombstone.

The Early History of Stainless Steel.

It is of paramount importance that the British steel manufacturers should be cognisant of a letter which has been printed by the Solingen (Germany) "Tageblatt" over the signature of Mr. P. R. Kuehnrich, of Messrs. Darwin's, Limited, Fitzwilliam Works, Sheffield.

To the Editor of the "SOLINGEN TAGEBLATT," SOLINGEN.

SIR,—Recently a copy of your paper, dated August 9, was brought to my notice, containing an article under the heading "A New Patent Dispute about Stainless Steel." As in this article my name and that of my company are mentioned, I would state that there can be no question of a patent dispute, as no basis exists for such a "dispute." The patents which I hold in all countries for steels for the manufacture of stainless articles are so clear that an attack on the same is not to be expected.

All that my company, Messrs. Darwins, Limited, has done up to the present is to refute the misleading statements made in "Messer and Scheere" by Messrs. Friedr. Krupp A.G., inasmuch as in my opinion the patent referred to by Krupp ought never to have been granted, because undoubtedly the same has only been the result of negotiations which took place many years ago between myself and Krupp with regard to the introduction of steels with high chromium contents.

To make this perfectly clear, I give below the actual history of the development of stainless steels about which many misleading statements have been published. In 1895 I was travelling in France on business. At that time the Sheffield firm of Marsh Bros. & Company, whose manager I was, supplied large quantities of steel for metal saw files. Whilst visiting a user of this steel, Messrs. Ebstein Frères in Jarville, near Nancy, Mr. Ebstein informed me that he had found another steel which gave much better results. This steel emanated from the firm of Jacob Holtzer. At that time hacksaws with set teeth were not generally known, and metal saws were made with a tapered back. The teeth of these saws were sharpened in the hardened state with small extra-hard three-square files, which naturally had to perform a very strenuous task, consequently all file manufacturers were on the look out for a better steel. Mr. Ebstein let me have a piece of the alleged "wonder steel," which I had analysed in Sheffield. To the astonishment of everyone concerned, it was found that the steel contained 2½ per cent. of chromium, which was considered enormously high, because at that time small chromium contents of ½ to 1 per cent. were the rule.

It was feared that more chromium would render the steel brittle, although it was already known that the firm of Jacob Holtzer was manufacturing a steel with a higher percentage of chromium for shells of high penetrating power. This steel was, however, not used for files.

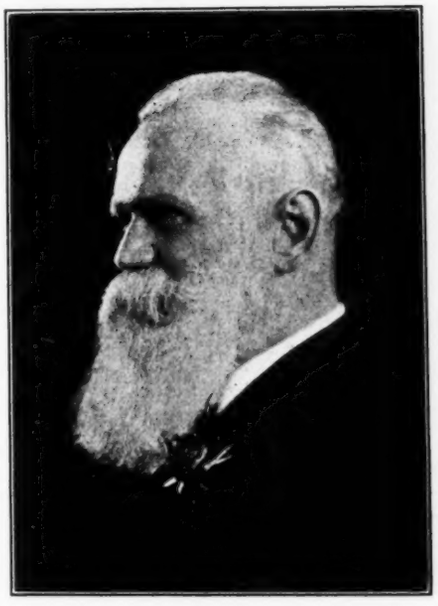
I then caused a trial cast to be made at the Marsh Works of a composition similar to that of Holtzer's material, which contained 1.3 per cent. carbon and 3.5 per cent. chromium. This gave excellent results, and was not only very suitable for files, but also for a number of other purposes, such as hacksaws, twist drills and razors. Articles made from this steel were then put on the market and became very favourably known under the "Roxo" brand.

Pocket knives for advertising purposes were also made from this steel, which I showed on my journeys as a curiosity. The blades were exceedingly sharp and had the peculiarity that, although the steel was very hard and would cut glass, the blades could easily be bent to an angle without breaking—a curious combination of great hardness and toughness.

During the period between 1895 and 1903 large quantities of this 3½ per cent. chrome steel were manufactured. Trials were made to increase the chrome to 4½ per cent. without any difficulties being encountered.

Having now conclusively proved that the higher percentage of chromium was possible and useful—in spite of the prevailing opinion that it was dangerous—it occurred to me that it would be interesting to find out up to what limits the chromium contents might be brought and yet to obtain a material capable of being forged and rolled.

In the autumn of 1903 I therefore had a series of ingots melted in our works, containing 6, 9, 15, 18, 21 and 24 per cent. of chromium. At that time carbon-free chromium was practically non-existent; Sheffield works generally used ferro-chrome with 6 to 8 per cent. carbon. Thus most of the ingots, especially the last four, came out too high in carbon. The ingots with 21 and 24 per cent. chrome could not be forged at all.



MR. P. R. KUEHNRICH.

After a few preliminary difficulties it was possible to forge the remaining ingots. Tests with 15 per cent. chrome steel led to the surprising discovery that, when made into turning-tools, this steel had similar qualities, and gave rather better results than the original Mushet self-hardening steel, which was at that time very popular.

The above-mentioned trials were, at all events, the first stages of the development and commercialising of high-chromium special steels. In my opinion, this occurrence constitutes the real birth of the fundamental properties of the high-chromium stainless steels.

A few months after these trials I resigned my position with Messrs. Marsh Bros. & Company. I entered into negotiations with the firm of B. Huntsman, in Sheffield, to take over the management of their entire business and to aim at a larger output of their famous carbon steels, as well as to introduce my new 15 per cent. chromium steel to the world's markets. A number of trial casts were made at Huntsman's works in the high-chromium steels, for which I have documentary evidence. Final negotiations to join the firm of Huntsman did not materialise, because terms agreeable to myself could not be arrived at.

I then formed the "Sheffield Steel Makers, Limited," and started the mass production of steel with 15 per cent. chrome and 1.4 to 2.5 per cent. carbon; 0.5 to 1 per cent. nickel was often added, because apparently this had a favourable influence upon the malleability of the steel. The steel became very popular and enjoyed a large sale. In a very short time I disposed of several hundred tons, chiefly in the form of tool steel under the "Unor" brand and as wire-drawing plates under the "Durex" brand.

Many thousands of gratis sample pieces, ⅜ in. sq., in lengths suitable for small turning tools, were sent out weekly to all parts of the world, especially to America, with a view to attract new customers.

Naturally attempts were made by many steel manufacturers to discover the ingredients of this new steel. This often led to microphotographic research, where grinding and polishing became necessary. It was known to me that in several instances the chemists carrying out the researches in the laboratories had observed that my new steel showed the peculiarity that pieces with polished surfaces which were left lying in the laboratory were not as usual attacked by the laboratory fumes and did not rust. They remained bright for a considerably long time. Undoubtedly at this time it was first recognised that steel with high-chromium contents resisted oxidation.

The activities of the "Sheffield Steel Makers, Limited," were interrupted after a short time, because a group of Sheffield steel manufacturers caused a boycott movement on the plea that the choice of name of my Company might create the impression that my Company was an association of all the Sheffield steel manufacturers.

"Sheffield Steel Makers, Limited," were therefore compelled to cease operations under that style, and I continued under the name of Darwin and Milner, which firm I have purchased.

As already mentioned, I developed a large turnover in the 15 per cent. chrome steel. I travelled myself. During one of my journeys in Rhenish Prussia I was informed at the Dom Hotel, Cologne, that a Mr. Schilling, director of the firm of Friedr. Krupp, in Essen, had inquired for me several times during the day. He left word that I was to telephone immediately on my return to the hotel. I had at that time no contact with the firm of Krupp, and thought that there was a misunderstanding. When telephoning I was asked to visit Essen, and I was told they wished to discuss the question of manufacture, under licence, of chrome steel made by my process. This took place on May 31, 1906. I went to Essen, and was presented on the following day to the board of directors. Discussions took place between myself and Messrs. Schilling, Ehrensberger and Dr. Strauss, and I was told that they were interested in the manufacture of chrome steel of a similar quality to those produced by me, because they were looking for improved alloy steels in their works for certain applications. Then followed a series of tests and investigations at Krupps, which finally caused Mr. Schilling to write me the enclosed letter, dated May 15, 1907. [Here follows the letter in question.]

When I called upon Krupps in answer to this letter, I was told that I should have to be satisfied with an amount of royalty similar to that which they paid to Messrs. Hadfields, Limited, for the licence of their patent manganese steel castings. They showed me a table which showed how this business had developed from small beginnings, and were of opinion that a similar development might take place with my steel. As far as I recollect the amount of royalty offered was 25 mks. per ton.

As however, my high chromium steel left me a very fair profit, I saw no advantage in Krupp's proposal, and declined, with the reservation, however, to leave the matter open for rediscussion at a later period.

During negotiations with Mr. Schilling it was mentioned that they would endeavour to get patent protection by adding certain ingredients

to the composition. A "gentlemen's agreement" was, however, mentioned, according to which Krupp would undertake not to manufacture this high-chromium steel or derive any advantage from my introduction, without coming to a firm understanding with myself.

The negotiations were later continued via the Grusonwerk, in Magdeburg, which belongs to Krupp, and of which my cousin, Mr. Carl Holzhausen, was chief engineer. Mr. Holzhausen, besides making castings from my high-chromium steel, undertook to demonstrate to Krupps in Magdeburg a process for nitronising Siemens Martin steel of low carbon which we were selling at that time under the "A.B.C." Brand. I treated in Sheffield Siemens-Martin billets 0.4 per cent. carbon, which were sent to me by Krupp, by heating and immersing in a nitronising fluid, and obtained results by which, according to the report of Mr. Holzhausen, tools of high quality could be produced. A turning tool so treated equalled a high-speed steel tool. I did not force the matter in Magdeburg, and the same was eventually allowed to drop. I am not aware whether Krupp has followed up my idea about nitronising. The negotiations with Krupp were continued until 1911, when I paid a visit to Mr. Schilling at Essen.

In my opinion, Krupp had no right whatever, without taking me into consideration, to take out a patent for a steel with less or more chromium, with less or more nickel, or with less or more carbon in opposition to the steels introduced by me, because such a plus or minus does not constitute an "invention" from a point of view of patent rights. The principle of an addition of nickel could not possibly be considered as an innovation, because before 1911 I had produced hundreds of tons of steel with 15 per cent. chrome and 0.5 to 1 per cent. nickel. I should not have thought it possible that the arrogance with regard to what I consider a colossal bluff could be carried to such an extent as expressed recently in threats through the medium of newspaper advertisements published by Krupp.

I had the intention in reply to these advertisements to publish my version of the history of the Krupp stainless steel patents, but I preferred to await Krupp's reply to our modest declaration published in "Messer and Scheere."

It appears at least strange that Krupp did not take out at the time the patents in his own name but in that of Mr. Hans Clemens Pasel, who was supposed to have "re-invented" the composition which was really my idea, by making a few variations.

It would be appropriate if the parties interested in the legal aspects of these patents obtained a declaration under oath from Mr. Pasel, who is described in the English patent specification as a clerk, as to whether he is the real inventor or whether he has only acted as "dummy." If the latter is the case, the question of studying the legal aspect might have to be considered, with the object of ascertaining whether I ought not to put forward a claim for part profits derived up to date by Krupp from the production of high-chromium steels. This claim would be based on the above-mentioned negotiations with regard to a licence and a possible creation of patents in our mutual interests. That the idea of such patents still existed in 1911 is proved by the enclosed letter of my cousin, Carl Holzhausen dated September 28, 1911, who as already mentioned, was chief engineer at Krupp's Guson Works, in Magdeburg, by whom the negotiations were then carried on.

The opinion which I have about the Krupp's Patent applies also to the British Firth-Brearley Patents, which are apparently being considered valid in Germany, America and several other countries. In the latter patent, only the carbon is lower than in my high-chromium steel which I had marketed previously in very large quantities.

I have followed with a certain feeling of compassion the development of the Firth-Brearley process as far as those industries are concerned which are using the material for the manufacture of cutlery.

It was recognised from the beginning that although knives made from this material had their advantages from the point of view of cleanliness, the cutting properties varied very much and generally were uncommonly bad. On the contrary, the introduction of this stainless steel has become a direct calamity for Sheffield, because the world to-day is now inundated with hundreds of millions of these faulty stainless knives, the majority of which possess very poor cutting edges, to such an extent that to-day in nearly every country the word "stainless" is synonymous with "bad cutting." Many cutlery manufacturers have lost their reputation through this unfinished and unreliable steel, and I almost consider it a mischief that it has ever been put on the market, apart from the evil caused by the establishment amongst a number of international "Quality" steelworks of an Exploitation Syndicate, which pooled their more or less strong real or sham patents, for the purpose of creating an equivalent to a reign of terror amongst the consumers of stainless steel. Especially in Germany and America the Krupp Patent No. 304126 is being used as a bugbear.

It is a cause of extreme satisfaction to me that amongst the compositions which I have developed during many years of study and research I have now been able to create a class of steel for stainless cutlery which, in my opinion, will bring forth a revolution of almost fundamental importance on the whole of the world's markets.

The P.R.K. Patent cutlery steel which is being manufactured by Darwins, Limited, in two varieties with different chrome and cobalt contents, makes it possible to produce knives of all kinds with rustless and stainless properties which, as regards keenness of edge and duration of cut, surpass by far any knives made from the very best carbon steels. With one kind of steel, of which considerable quantities are being supplied to one of the largest Solingen cutlery concerns, tests were carried out recently on a machine for testing the cutting edges of knives, with the result that in comparison with a 1 per cent. carbon Swedish steel the P.R.K. Patent steel registered with double feed a quadruple duration of cut.

It is intended to make the P.R.K. Patent steel accessible to all the markets of the world from the beginning of the late autumn. All concerns manufacturing cutlery will be able to obtain deliveries without any restrictions as to export. Messrs. Darwins further intend to consider establishing, in the near future, works in America and Germany for the production of this class of steel on a large scale.

In this manner a new era will be brought to life for the benefit of the community in the manufacture of cutlery of the highest cutting properties, which will excel in quality the very best cutlery made from carbon steel manufactured before the introduction of stainless steel.

(Signed) P. R. Kuehnrich.

[In the next issue of The Foundry Trade Journal we propose to print a commentary upon Mr. Kuehnrich's important communication to the German Press, together with any remarks our readers may have to make.—Editor.]

A Set-back to Welding as a Competitor to Castings.

(*Continued from page* 183.)

subjected to the same exhaustive tests as has been the lot of the product of the foundry industry for many years. The Report quoted should be an incentive to the foundry industry, collectively and individually, to apply the results of available researches to their output with the dual object of reducing costs and increasing the mechanical properties and general soundness of cast products.

Random Shots.

Last week I mentioned that my friend in Madeira had set his moulders to wash the foundry walls. About the same time I was interested to see that Zancig, the mystery man, who died recently, began life as a moulder in an American iron foundry. I have commented before now on the present Foreign Secretary's connection with our own trade. I am tempted to the reflection that either moulding must develop great versatility in those who practise it, or it must appeal to a versatile type of man. Ex-moulders are to be found doing all sorts of things, and experience on the foundry floor is apt to pop up in the most unexpected obituary notices. I believe that somewhere on our coasts there is a builder of marvellous sand castles who acquired his skill in the same school. . . . Not that I would advocate moulding as a training for Cabinet Ministers, variety entertainers, or seaside virtuosi; we want to keep our moulders when we have trained them!

* * *

As one who reads my Foundry Trade Journal from cover to cover, I understand that some few among you will, at the date when these words appear in print, be disporting yourselves in Düsseldorf. I say disporting advisedly, since I am given to understand that any excuse for a good time is better than none where foundrymen are concerned, and that no excuse is so good as that of having undertaken a strenuous trip to "furrin parts" in the cause of business. I seem to remember a Foundry Exhibition in Paris, not so very long ago . . . and I have even been told of a previous visit to Germany . . . though that was before "Marksman's" time—not his time in this world, be it understood, but his time in this paper!

* * *

Others of you will, round about the same time, be disporting yourselves in similar fashion at the Iron and Steel Institute meeting in Newcastle, and others again, perhaps, not so very much earlier, at the Institute of Metals, also in Düsseldorf. And others will be staying at home. . . . It is of the last group that I am thinking to-day, and for your benefit I am going to retale a tale or two. (Dear, dear, we shall have to do something about this punning habit "Marksman's" getting into!) Incidentally, these, and others that are to follow them, will serve another purpose than that of cheering the unhappy stay-at-homes. They will be of inestimable assistance to those of you who have a reputation in the matter of after-dinner speeches, since the banquet season is all but upon us. Only don't use them where other foundrymen forgather; you aren't the only one to read this column, and the point is apt to be lost if your audience know where it came from!

* * *

A customer went into a restaurant and ordered a lobster. When it came he inspected it at some length, and then asked the waiter: "Why has this lobster only one claw?" "Well, sir," said the waiter, "you see, our lobsters are so fresh that they fight in the kitchen." To which the customer replied, "Well, bring me a winner, then."

* * *

This is a story of Lord Dewar, that prince of after-dinner wits. His lordship was once partnered at dinner with an attractive young lady whose name was Porter-Porter. Either he could not, or would not, remember this fact, and when the lady had been addressed several times as Miss Porter, she said pointedly: "My name is Porter-Porter, with a hyphen." "Ah, yes, my dear young lady," his lordship replied, "just as mine is Dewar-Dewar with a syphon!"

Marksman.

"The Pilot Press."*

By Barrington Hooper, C.B.E. (Managing Director of the "Foundry Trade Journal").

It should be made clear that the industrial Press is generally divided into two main classes: (1) Those publications which cater for the manufacturer or producer, the editorial of which is largely devoted to the highly technical Papers that are read at the Institutes which are connected with each industry, and naturally carrying the advertising of the plant and machinery that the readers of the journal use and need; (2) those journals which deal with the distributing trade. As an example, one would mention a textile journal, which is read by mill-owners, spinners, etc., and deals with textile processes and machinery; another example is a drapers' paper, which deals with such matters as classes of fabrics and all matters relating to their selling.

In dealing more specifically with those papers of a highly technical nature, circulating primarily among the manufacturers, founders, mine-owners, etc., it can be postulated that this type of industrial newspaper has many points in common with a pilot. The great ship of industry, carrying a large crew, or employees, and a vast cargo of valuable merchandise, safely negotiates the mighty oceans of production, but when it comes to the delicate and intricate task of completing its journey, that is, entering the harbour of salesmanship, it needs the skilled guidance of the pilot. It is on these occasions that one man with skilled and expert knowledge of his particular subject is of greater value than all the powerful turbines that have brought the mighty vessel thousands of miles, through the troubled waters of production; he is a necessary, or rather essential, addition to the crew; he is, indeed, as essential to the ship as is a trade journal to the industry it serves.

Nor does the parallel end here. The writer could continue to draw similes of this character, but has contented himself with one further comparison—he could conceive of no greater danger than an unskilled or incompetent pilot, if such existed; and in like manner an industrial journal carries grave responsibilities. But the stern law of economics is a ruthless taskmaster, and any inefficiency on the part of an industrial publication is speedily rewarded by extinction; it is safe to assume that the industrial journals of Britain have all rendered tried and trusted, indispensable service to their industries, particularly when it comes to the latter stage—the most difficult of all—that is, the marketing of a finished product.

The author was present last spring at the British Advertising Convention at Newcastle, and attended the session devoted to the Trade and Technical Press, and listened with interest to a speaker who, for some reason the author has not yet been able to fathom, argued his personal point of view that if he were given a commodity to sell which was very technical and specialised, he would for this purpose use the national Press in preference to a technical or industrial journal. The writer put to him the plain question as to how, were he called upon to do so, would he market such an article as a coal-cutter or, say, a ventilating fan for a colliery, where there is only a very limited number of purchasers, all of whom require to know more than the brief details that could appear in an ordinary newspaper advertisement, the cost of which alone would be prohibitive. He held his hands above his head and admitted defeat, as will any man who despises the efficiency of the trade journal. Were he to attempt to advertise heavy machinery in the national Press, the cost would render it impossible, for although the advertisement might be seen by some million readers, less than one-tenth of one per cent. of them would be possible purchasers of the article he was trying to sell, whereas if the advertisement appeared in a paper devoted exclusively to the interests of a particular industry, one can take it that approximately 100 per cent. of the readers would be interested persons, if not actual buyers. Furthermore, no great industrialist will purchase a new type of machinery, costing maybe large sums of money, until he knows all about it, and this is where the trade Press pilots manufacturers to the successful anchorage of a completed order.

Trade journals worthy of the name have on their staff skilled experts ever on the look-out for new machinery, new apparatus and new plant of every kind, and the industrialist can rely, with that same implicit confidence as captain, crew and passengers rely upon the pilot, upon receiving an accurate and true description, detailed and specific, of each new invention or device, thereby enabling him the better to judge the advantages that would accrue as a result of its introduction into his own works, factory or pit.

The Danger of "Inspired" Articles.

It will readily be seen how important, therefore, is the integrity of the trade journal. Any paper, and there are always some black sheep in every fold, that is prepared to give a favourable write-up in return for an advertisement, is a danger to the community and a disgrace to its industry, and, fortunately, very soon ceases to exist, by reason of the fact that its editorial opinions can no longer be relied upon. The writer is prepared to say, without fear of contradiction, that in the old-established trade and industrial newspaper, be it British, American, Continental, or whatever the country it is published in, the editorial opinion is sacred and cannot be influenced in any way by pressure in its advertising pages; this one fact alone gives to the trade journal its supreme and unassailable position as an essential and indispensable medium for the marketing of commercial products, and it is up to the advertiser, as well as the reader, to see that this high standard is maintained by refusing to support any journal that is prepared to give a biased editorial support in return for advertising remuneration. He is glad to state that this form of inverted blackmail is practically non-existent in the realms of recognised trade publications.

Co-ordination of Advertising Effort.

On a recent tour round the North of England the author was speaking with a large manufacturing firm, suppliers of heavy machinery, who told him they had found the best media for marketing their goods was the distribution of catalogues accompanied by explanatory circular letters, and that they had recently carried out a campaign, sending out some thousands of such circulars and catalogues to various groups of industries. They were surprised to find that from one particular branch of industry they had had an immensely successful response, whilst from another branch of industry they had had but two or three replies, none of which indicated definite business. The manufacturers' solution of this conundrum was that the first industry was in a more successful and prosperous condition than the other, and therefore was in a better position to buy the plant. The writer was not satisfied with this explanation, as it was not supported by facts, both industries being prosperous, and he subsequently discovered the firm in question were regular advertisers in the technical papers that served the first industry, and therefore their name was well known to those in the industry; so their circulars were carefully read and studied, as one gladly reads a letter from an old friend in preference to one that comes from someone unknown. He also found they had not inserted their advertisements in the trade and technical papers serving the second industry. He pointed this out to the firm, who were loth to increase their advertising appropriation. Eventually, however, he persuaded them to do so, and after a period of some months of constant advertising, they again sent their circulars and catalogues to that particular industry. The result entirely justified the experiment. Firms in the latter industry received the letter from a firm whose name was now known to them; they read it with the attention it warranted, and business and orders resulted.

This is only yet another instance of the supreme value to any trade of a well-organised, reliable and efficient trade Press, and the author has no hesitation in saying, in conclusion, that the prosperity of any industry is dependent to an extent that few yet realise on the efficiency, integrity and enterprise of its trade and technical Press. The writer would finish up, as he started, by saying that the trade Press is as essential to the ship of industry as is the pilot to the ocean-going liner.

* A speech delivered at the Industrial Advertisers' Section of the International Advertising Convention, Berlin, 1929.

New Plant of Scottish Steelworks.

It is of interest to note that Scottish steel manufacturers are carrying out modifications and alterations in their plant with a view of maintaining efficiency and being able to solve the problem of regulating their productivity to meet the markets available. The latest instance of this is the alteration made by the Steel Company of Scotland, Limited, at their Hallside Works, Cambuslang, near Glasgow. The modification in the melting department consists in the replacement of three of the older melting furnaces by two new open-hearth furnaces of increased capacity and embodying the latest practice in design and building. Full use has been made of insulating material to keep down the heat losses by radiation. A further economy is effected by the installation of fire tube-type waste-heat boilers, whereby the heat in the chimney gases from the melting furnace is used to generate steam. The methods of handling materials at the furnace and for charging are of the most modern description.

A new cogging mill drive, supplied by the Electric Construction Company, Limited, Wolverhampton, is, we are informed, the first of its kind, and comprises a flywheel generator set driven by a steam turbine and a pipe-ventilated motor of 7,500 b.h.p. capacity, which is directly coupled to the cogging mill. The whole of the change over from the old steam drive of this mill, involving new buildings, scrapping old plant, etc., was carried out without interruption of the normal working of the rolling plant.

Assessing Foundry Subscription Rates.—We have on several occasions taken part in discussions as to the assessing of subscriptions for co-operative schemes amongst foundry establishments and appreciated the difficulties involved. The following ratios have been utilised by the National Founders' Association (America) with considerable success, and are worthy of study in this connection:—

Cost of Membership

(based on number of moulders and coremakers).

		Monthly Subscription.	Entrance Fee.
A	Floor moulders skilled in the general trade of moulding	12 ...	500
B	Bench moulders skilled in the general trade of moulding	10 ...	420
C	Moulders' apprentices ...	8 ...	340
D	Speciality moulders not skilled in the general trade of moulding ...	8 ...	340
E	Moulding machine operators	8 ...	340
F	Coremakers (journeymen) ...	10 ...	420
G	Coremakers, unskilled (male or female)	8 ...	340
H	Coremakers' apprentices (male or female)	8 ...	340

The figures given in this table represent the relative amounts demanded.

Institute of Metals.

ANNUAL AUTUMN MEETING.

The Annual Autumn Meeting of the Institute of Metals was held this year in Düsseldorf, from September 9 to 12. Synopses of some of the various Papers presented at the meeting are printed below.

Eighth Autumn Lecture: Aluminium and Its Alloys, by Dr. A. G. C. Gwyer, B.Sc.

The lecture contains a brief account of some of the more important investigations which have been carried out in recent years upon aluminium and aluminium alloys. Attention is directed to the outstanding characteristics of these alloys, and there is given a short account of recent work that has been done to improve the general reliability of aluminium and its alloys, more particularly from the points of view of soundness and resistance to corrosion. The constitution of the more important aluminium alloys, and of aluminium itself, is described. Of recent years the question of the heat-treatment of aluminium alloys has received considerable attention. Therefore a considerable proportion of the lecture is devoted to the subject, which includes, of course, reference to the phenomenon of age-hardening. The lecture concludes with a short account of the application of the methods of X-ray spectrography to aluminium—a subject which the lecturer regards as of very great importance, and one which is likely to yield very valuable and practical results in the near future.

Some Methods of Research in Physical Metallurgy, by Walter Rosenhain, D.Sc., F.Inst.Met., F.R.S. (President).

The Paper describes the methods which have been developed in recent years, and particularly in the Metallurgical Department of the National Physical Laboratory, for the study of metals, especially in connection with the determination of equilibrium diagrams. The methods of determining and recording thermal curves, resistivity-temperature and dilatation-temperature curves, are discussed in detail, and a brief account is given of a novel form of electrical dilatometer, making use of measurements of the capacity of a small condenser, which is varied by the dilatation of the specimen. The measurement of this capacity is made by means of oscillatory circuits utilising thermionic valves, and the resulting graph is plotted by means of an electrical "thread recorder." Reference is also made to the development of optical pyrometry, and a novel method of securing black body conditions, by sighting upon the interior of a gas bubble blown in a mass of molten metal, is described. The applications of the study of structure by means of the microscope and of crystal lattices by means of the X-ray spectrometer are discussed in regard to their bearing upon the equilibrium diagram. Finally, stress is laid upon the importance of securing accurately known composition and the highest possible degree of purity in the metals and alloys used for investigations of this kind. Reference is made to the methods for producing metals of high purity, and the development of special refractories for that purpose, which have been developed at the National Physical Laboratory.

Methods of Research in Metallography, by G. Masing, Dr. Phil.

The fundamental principles underlying the methods of research employed in investigations on the constitution of alloys and in physical metallography are discussed, and it is shown that researches on the constitution of alloys must be based on the well-established thermodynamical laws of heterogeneous equilibria. The experimental methods are, however, not sufficient for accurate work and need to be improved in precision and amplified (especially X-ray technique). The most important improvement required is the development of a method for the rapid attainment of equilibrium in an alloy. Besides the establishment of equilibrium diagrams the study of constitution nowadays demands an investigation of the condition of alloys far removed from the state of equilibrium; the theoretical and experimental aspects of this problem are considered.

In physical metallography the greatest interest is evinced in the study of plastic deformation and its attendant phenomena (hardening, recrystallisation, etc.). The importance of using precise physical methods in order to make further advances in this field is emphasised.

A Dilatometric Study of Some Univariant Two-Phase Reactions, by P. Chevenard, A. M. Portevin and X. F. Waché.

The authors have investigated, by means of a dilatometer, the reactions taking place in quenched aluminium-copper and aluminium-silicon alloys, when annealed at various temperatures. The laws of precipitation during constant temperature annealing, and the influence of temperature on the speed of precipitation, have been studied. A hitherto unknown reaction has been found and partially elucidated. Alloys of iron, nickel and copper have also been investigated by means of the dilatometer, and the boundary of the two-phase field on the iron side of the system has been determined.

The Open-Air Corrosion of Copper. A Chemical Study of the Surface Patina, by W. H. J. Vernon, D.Sc., Ph.D., F.I.C., and L. Whitby, M.Sc., A.I.C.

The patina on copper after prolonged exposure to the open air has been studied, samples having been taken from copper structures in urban, rural and coastal districts respectively. Provided the exposure has been sufficiently prolonged, and in the absence of certain prejudicial circumstances a pleasing green patina characterises the metal surface in each type of atmosphere. Frequently (in urban districts invariably), the metal passes through a preliminary black stage, the persistence of which is favoured by the presence of lead in the metal and by shielding from wind and rain. In general, the green patina consists essentially of basic copper sulphate. An exception to this is the product from a purely marine atmosphere, in which basic copper chloride predominates; where urban and marine conditions coincide, however, then basic sulphate in the product greatly predominates over basic chloride. Contrary to the general belief, basic copper carbonate enters only to a minor extent into the composition of the product, even in rural districts remote from sea and town. Sulphur compounds, derived from products of combustion and disseminated by wind, are the most potent agents in the development of patina. The underlying metal, after long periods of exposure, shows remarkable freedom from pitting. With the exception of lead, which tends to accumulate in the product, the impurities usually present in the metal have no appreciable effect on the composition or appearance of the patina.

The Creep of 80:20 Nickel-Chromium Alloy at High Temperatures, by A. Glynne Lobley, M.Sc., and C. L. Betts, Ph.D.

Wires of 0.018 in., 0.0625 in., and 0.25 in. thick were subjected to tensile stresses of 50, 100, 200 and 400 lb. per sq. in. at temperatures of 700, 800, 900 and 1,000 deg. C. for a period of approximately 4,000 hrs., and accurate measurements made daily of the movements. At the highest temperature there was no evidence of creep stress limit. The rate of flow was found to be dependent on the diameter of the wire as well as on the other factors. The progress of the experiments is given in the form of abridged graphs, and graphs are also used to show the relationship between the various conditions of temperature, stress and diameter.

The Reduction of Shrinkage Cavities and Vacuum Melting, by W. J. P. Rohn, Dr.Phil.Nat.

Shrinkage cavities may be diminished if care is taken that the solidification of an ingot starts from its bottom end and advances gradually to the top end. This control of the freezing process is not obtainable by using sand-moulds or cast-iron moulds, but can be approximated to a certain extent with water-cooled copper moulds. The special construction of such moulds, to be used in connection with vacuum melting furnaces, is described, and some details given regarding vacuum melting.

Shrinkage cavities, it is shown, may be totally avoided if melting and freezing are performed in an electrically heated melting furnace in a crucible of the shape of a finished ingot, and, after melting and refining is completed, the current is cut off gradually from the bottom with a well-controlled speed. Illustrations of cross-sections of ingots so produced, and of their crystal structure, are given.

Progress in Electric Furnaces for Non-Ferrous Metals, by M. Tama, Dipl.-Ing.

New induction furnaces of large capacity are described. They have been developed for high melting-point alloys, such as nickel-brass and phosphor-bronze. Thirty-four electric annealing furnaces of the resistor type are shown to be in successful operation in a large metallurgical plant. The advantages of the use of electricity both for melting and annealing non-ferrous metals are emphasised. Recent improvements in refractory linings for melting copper alloys, devices for charging swarf into electric furnaces, and various types of electric bright annealing furnaces are described.

Pinholes in Cast Aluminium Alloys, by N. F. Budgen, Ph.D., M.Sc.

The Paper describes an investigation into the causes of pinholes in sand-cast aluminium alloys, and describes the various forms of pinholes that are seen. The notes are confined largely to the observation of sand-cast test-blocks 3 in. in dia. by 3 in. deep. Gas evolution at solidification is considered to be the causation factor of greatest importance, and the means whereby gases may be absorbed by aluminium alloys are discussed. Shrinkage during solidification is considered to play some part in producing pinholes.

The influence of the aluminium ingot itself, the melting and pouring temperature, the time maintained molten, the melting fuel and furnace, the rate of solidification, the turbulence of pouring, and the alloying elements are separately considered in relation to their effect on pinholing. Means for preventing pinholes are described.

The Relative Corrodibilities of Ferrous and Non-Ferrous Metals and Alloys. Part II—The Results of Seven Years' Exposure to Air at Birmingham, by J. Newton Friend, D.Sc., Ph.D., F.I.C.

Fifty-four bars of ferrous and non-ferrous metals were exposed to air on the roof of the Birmingham Central Technical College for seven years, and an account is given of the 17 non-ferrous bars. The metals examined included tin, lead, nickel, zinc, aluminium, and various coppers and brasses. All resisted corrosion much more efficiently than the wrought iron and carbon steels. Nickel proved less resistant than copper. Aluminium ranked with lead, tin, and stainless steel in offering a very high resistance to corrosion. The influence of arsenic on copper is discussed.

XUM

Corrosion of Various Alloys in Combusted Coal-Gas Condensate.

By W. E. Dennison.

Considering the wide claims made for the non-corrodibility of various alloys under certain conditions, it is surprising to find that little appears to be known by the manufacturers of such alloys as to their resistance to corrosion when subjected to whole or part-immersion in coal-gas combustion condensate. As is well known, the hydrogen of coal-gas is oxidised to water during the process of combustion and this water forms a solvent for some of the carbonic-acid gas produced by the combustion of the carbon, the resultant solution having a weak but definite acid character. In addition, the sulphur dioxide resulting from the small amount of sulphur compounds originally present in the gas, forms sulphurous acid by combination with the water, and this acid, although present in only small quantity, may be particularly severe with certain metals and alloys.

It is generally realised that accelerated corrosion tests carried out in a laboratory may give very misleading results. Usually this is because, to obtain acceleration and a quick reading, it is necessary to use a more concentrated form of solution than that which occurs in the particular case to which the problem refers. Often, the main chemical reaction occurring during corrosion is masked by consecutive and concurrent reactions which are modified considerably by the strength of the solution. Although it is difficult to draw the line between chemical actions and electrolytic actions, the latter undoubtedly occur as a primary factor, particularly where metals of different electrical potential are in juxtaposition, or, where an alloy is badly balanced, small voltaic couples can be set up. Again, as soon as localised corrosion commences from any cause, that part covered by the resulting compound may become the positive pole of a galvanic couple, which explains the accelerated anodic corrosion known as pitting. However, this concentration strength of the electrolyte, along with other factors, decide whether the action is to virtually cease owing to polarisation.

These are the reasons why the results obtained by any form of artificial or laboratory test made to accelerate the corrosive action must be interpreted with great care if misleading conclusions are to be avoided.

It will be agreed that valuable indications have been obtained by immersing metal specimens in the sea for protracted periods in such a position that the tidal movements have produced either a periodical wet and dry condition or constant total immersion. These tests have their value in being made under practical concentration conditions. It was felt that similar practical values could be obtained, as to the relative corrodibilities of various metals and alloys, when subjected to the corrosive action of the acid products of coal-gas combustion, by wet and dry treatment with uncontaminated, unspent condensate. The latter was collected by means of the arrangement shown in Fig. 1.

It is a simple device whereby the products of combustion from a Bunsen burner are aspirated through a Liebig condenser, the weak-acid solution formed being collected in a small-necked bottle.

Analysis of the Condensate.

The unspent condensate was analysed for carbonic-acid gas, sulphurous acid and sulphuric acid, with the following results:—

Carbonic acid, expressed as free CO_2 .. .. = 26 grains per gallon.
Sulphurous acid, expressed as free SO_2 .. .. = 21 „ „
Sulphuric acid, H_2SO_4 .. = small but distinct trace.

Only a trace of the sulphurous acid had oxidised to sulphuric acid during the combustion process. It is surprising to find so much sulphur dioxide present in relation to carbonic oxide, and it is evident that the sulphurous acid plays an active part in the gas-condensate corrosion problem.

Samples of various metals and alloys were obtained and strips measuring about 80 mm. by 25 mm. prepared, and the surface areas measured carefully. After weighing on a sensitive balance each specimen was placed in a separate 7-in. by 1¼-in. test-tube in order to avoid any chance of galvanic action occurring between the metals owing to their different electrical character.

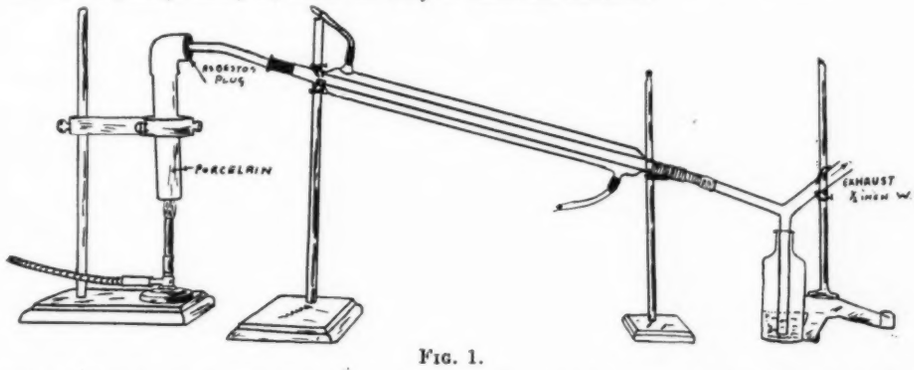


FIG. 1.

The test-tubes were placed in 1,000-c.c. beakers containing a suitable quantity of water for warming, as shown in Fig. 2. Each specimen was then immersed in 70 c.c. of the condensate and the beakers placed on the top of an air bath. The latter being used daily, the temperature of the solutions varied from 50 to 120 deg. Fah. (10 to 48 deg. C.), according to the chemical laboratory demand for the use of the air bath. These temperature variations were not therefore regular, but care was taken to ensure that each specimen received the same treatment. Evaporation was minimised by covering the test-tubes so that no specimen was partly dry during the actual immersion periods. At the end of a week as much as possible of the supernatant liquid in each test-tube was decanted without disturbing any of the corrosion product which had adhered to the specimen or had precipitated, and the specimens were left in this mostly dry state until the next day. A further 70 c.c. of the condensate was then added and the treatment continued exactly as before. Over a period of two months, therefore, this cycle occurred eight times and each specimen had been treated with 560 c.c. of gas condensate.

At the end of this period the specimens were removed and cleaned by means of running water and digital abrasion before drying and weighing. The results obtained, which were confirmed, are given in Table I.

FIG. 2.

Interpretation of Results.

In interpreting the results, allowance should be made for the relative densities of the various samples, as the real index of the loss is dimensional rather than gravimetric, as an apparatus should not be made any thicker than normally in light alloys owing to commercial considerations. The light alloys, Samples Nos. 13, 14 and 15, which are designated commercially by the wide term "non-corrodible," having about one-third of the density of the other samples, need to be considered in this light.

The outstanding result is that of the hot-galvanised specimen of cast iron, which is remarkably resistant to corrosion in the condensate. The hot-galvanised specimen is, in fact, over the period of tests, six times as resistant as the cold or electro-galvanised specimen. The zinc coating given by the hot process is, of course, heavier than that of the electro process, but this does not account for the decided difference in the corrosion-test results, which were confirmed by further experiments. It is usually held that the so-called cold-galvanising produces a more corrosion-resisting deposit, which is probably true for certain conditions, but under the conditions existing for this research, hot galvanising is proved to be definitely superior in the matter of resistance.

Copper, 70:30 brass and Monel metal are indicated to resist to about the same extent as each other, the losses of weight showing that these metals resist the conditions relatively well.

There is an apparent anomaly in the results of the ferrous metals with skin on and skin off. It is generally accepted that the skin protects the underlying metal from corrosion, but this presupposes a perfectly continuous skin, which in practice is not likely to occur. In the tests here recorded the "skin-on" specimens are shown, for cast iron, wrought iron and mild steel, to lose more weight by immersion than the "skin-off" specimens. The explanation must be in the discontinuous conditions of the skins setting up anodic corrosion and permitting

even the purely chemical action to permeate under the broken skin of the oxide so that the latter is not only removed on cleaning by digital abrasion under running water, but is responsible for a series of local anodic or positive pole-corrosion accelerations.

The "skin-off" specimens provide, therefore, the best index to the relative resistance of the ferrous metals, and it is interesting to record that the order of resistance is cast iron, mild steel and wrought iron. The analyses of the ferrous metals used are appended:—

Table I.—*Relative Corrosion on Alloys in Gas Condensate.*

No.	Sample.	Relative density.	Area cm².	Original grams.	Weight after 1,400 hrs. Grams.	Loss mgr.	Loss mgr. Per sq. cm.
1	C.I. skin on	7.2	47	61.0210	60.7450	276.0	5.88
2	C.I. skin off	7.2	48	65.9640	65.8040	160.0	3.33
3	C.I. Zn plated	7.2	47	62.5210	62.4200	101.0	2.15
4	C.I. hot Zn	7.2	50	67.5480	67.5310	17.0	0.34
5	W.I. skin on..	7.7	44	75.5230	75.2660	257.0	5.84
6	W.I. skin off..	7.7	48	80.5960	80.3470	249.0	5.19
7	Mild steel skin on	7.8	49	50.2780	50.0060	272.0	5.55
8	Mild steel skin off	7.8	51	52.3830	52.1790	204.0	4.00
9	Copper	8.9	44	29.2400	29.1660	74.0	1.68
10	Brass 70–30	8.4	48	24.6675	24.6050	62.5	1.30
11	Monel metal	8.8	46	18.4150	18.3390	76.0	1.65
12	Lead	11.3	48	28.8870	28.6930	194.0	4.04
13	N.C.A. (aluminium alloy) ..	2.8	53	26.0065	25.9930	13.5	0.255
14	Special „ „ ..	3.0	49	18.2510	18.2120	39.0	0.796
15	„ „ „ ..	2.7	50	17.2880	17.2530	35.0	0.70

	Si.	G.C.	C.C.	P.	S.	Mn.
Cast iron ..	2.25	2.95	0.44	0.59	0.05	0.65
Steel ..	0.10	—	0.50	0.06	0.06	0.72
Wrought iron	0.15	—	0.12	0.11	0.045	0.12

The resistance will most probably be different with specimens of other composition, but will no doubt be in the same order as that named.

Conclusion.

On the whole, the results indicate that where the conditions are similar to that existing for these tests, the condensation resulting from the combustion of coal-gas is not so strongly corrosive as is generally conceived. Ferrous metals may be best protected by means of hot galvanising, the tests indicating that an article so protected should have a reasonable life. It is well known that zinc stands up well against carbolic acid under wet and dry conditions, and it is apparently also true of sulphurous acid of the strength quoted.

The special light alloys, Specimens 14 and 15, which may be considered non-corrodible under certain conditions, sea-water immersion for instance, have no special virtues as far as resistance to corrosion by gas condensate is concerned. In this case the volume loss must be considered. Specimen No. 13 of N.C.A. aluminium alloy gives, however, a very good result, even taking into account its volume loss. Its specific gravity is 2.8 and it therefore should prove very useful where low weight and high corrosion resistance are the desiderata.

Although the results show copper and brass to be similarly resistant, it would be advisable to consider copper superior, as time may be a factor in its favour as against the binary alloy, brass. Although this research is certainly incomplete and is almost impossible of completion in the sense of the numerous alloys which might be subjected to tests, it is felt that the results obtained from the specimens tested give valuable indication which, with discretionary interpretation, may prove of practical value.

Included in the work which Messrs. J. Stone & Company, Limited, have in hand at their Charlton works are propellers for the new Canadian Pacific liner "Empress of Japan," a 25,000-ton vessel for the Pacific trade. Each of the propellers will weigh over 20 tons.

Pneumatic Hammer for Tapping Furnaces.

In order to provide a suitable mechanical device for tapping blast furnaces, even under the most difficult conditions, the German United Steel Works, in conjunction with the "Demag" Company, have recently brought out a pneumatic hammer which, by means of a rod, pierces the tapping hole and then withdraws the rod, both operations being performed very quickly. The hammer is described and illustrated in a recent number of "Stahl und Eisen."

The hammer consists essentially of a cylinder (*a*), a stirrup (*b*), a piston (*c*), a valve gear with spring enclosed in (*d*), a percussion piece (*e*), a front cylinder cover (*f*), two tension bolts (*g*), a crosshead with coupling lug (*h*), a pin (*i*), a cover (*k*), and two detachable bell-crank levers (*l*) fitted for guiding the hammer. When used for piercing the tapping-hole, the hammer is suspended on a roller running on a rail about 16 ft. long placed parallel to the iron gutter and about 13 ft. above it. This rail can be swung down to one side to enable the hammer to be removed conveniently when it has done its work.

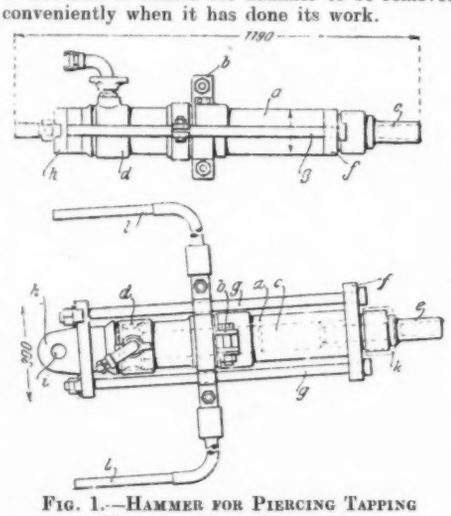


Fig. 1.—Hammer for Piercing Tapping Holes of Blast Furnaces.

The first operation consists of driving the rod into the tapping-hole of the furnace. For this purpose the hammer is brought up to the tapping rod until the latter comes up against the bore in the percussion piece (*e*). The rod is then driven into the tapping-hole to the requisite depth. To withdraw the rod, the hammer is swung through an angle of 180 deg., the percussion piece (or striker) (*e*) is removed, and the bore in the cylinder head closed with the cover (*k*). The hammer is then firmly secured to the tapping rod with a ring and cotter. The impact of the piston now acts upon the front cylinder cover (*f*), which forms a cross yoke and carries two tension bolts (*k*). These transmit the piston impact, in the form of a pull, on the yoke with the coupling lug (*h*), thus enabling the rod to be pulled out of the tapping-hole.

The new tool can be used also for several other operations in connection with furnace work, as, *e.g.*, for drawing out tuyeres and tuyere casings that have seized, withdrawing slag tuyeres and their casings, etc. When used in this way, the tapping rod is replaced by a special tuyere hook. As the length of pull required in this case is very short, the hammer can be slung on a chain or wire rope at any convenient point above the working platform.

The following instance of use in a service interruption demonstrates the all-round utility of the new tool. Shortly after a blast furnace had been blown in, a shoulder-piece in the boshes had worked loose, causing molten iron to break through between the tuyere-protecting casing and the cast-iron housing and partly burning the protecting casing and the blast tuyere, besides causing an explosion of oxy-hydrogen gas which badly distorted these two parts. Due to the flow of water ensuing, the iron and slag that had penetrated were quickly cooled down and the two damaged parts in question became an unshapely mass. All attempts to withdraw the blast chest in the usual way with the tuyere hook proved abortive at first. The first usual thing to do would have been to melt the tuyere free with oxygen, a job that would probably have taken three hours. Using the new tool for withdrawing the casing with the tuyere, the whole job, including bringing up the hammer, took no more than five minutes. The total time of stoppage up to the time the furnace was connected up to the gas supply was only 30 minutes.

Contracts Open.

Belgium, October 10.—32 electric travelling cranes, portal type, for the Antwerp Municipality. The Department of Overseas Trade. (Reference A.X. 8,447.)

Cairo, September 21.—Cast-iron spigot and socket pipes, for the Public Works Ministry, Tanzim Department. The Department of Overseas Trade. (Reference A.X. 8,396.)

Johannesburg, October 17.—Mild-steel buffer nuts, for the South African Railways and Harbours Administration. The Department of Overseas Trade. (Reference B.X. 5,635.)

London, S.W., September 13 to October 7.—Steel ballast wagons, steel sleepers, copper rods and tubes, brass sheets, converter equipment for substations, transformer switchgear and accessories, overhead transmission line, and structural steelwork, for the South Indian Railway Company, 91, Petty France, Westminster, S.W.1. (Fees, which are non-returnable, vary from 2s. 6d. to £1.)

Lourenco Marques, October 10.—Two steel wagons (0.75-m. gauge), for the Tendering Department of the Treasury of Lourenco Marques. The Department of Overseas Trade. (Reference A.X. 8,468.)

Lourenco Marques, December 30.—Parts of locomotives and rolling stock, for the Board of the Port and Railways. The Department of Overseas Trade. (Reference A.X. 8,439.)

Salisbury, S.A., October 17.—H.t. cables, transformers, etc., turbo-alternators, steam piping, crane and switchgear, for the Municipality of Salisbury. The Department of Overseas Trade. (References B.X. 5,604 and 5,607.)

Publication Received.

Modern Industrial Furnaces.—This is the title of a bulletin to be published at frequent intervals by Messrs. Stein & Atkinson, Limited, of 47, Victoria Street, London, S.W.1. The first number contains three technical articles dealing with Fuel Oil *v.* Coal; blast-furnace gas-fired soaking pits, and small furnaces for drop-forging and the like. As a machinery list is now being compiled for this publication, those of our readers interested in furnace practice should make application, as many of the Stein productions are of considerable advantage in modern foundry developments.

The Importance of the Brackelsberg Furnace for the Iron Foundry.

By Dr. P. Bardenheuer.

(*Abridged translation from "Die Giesserei," November 23, 1928.*)

In our issue of April 4, pages 257 *et seq.*, an article from the pen of Dr. Kalpers described and illustrated the Brackelsberg furnace as applied to the manufacture of malleable cast iron. The following deals more particularly with the application of the furnace for the production of high-grade grey-iron castings.

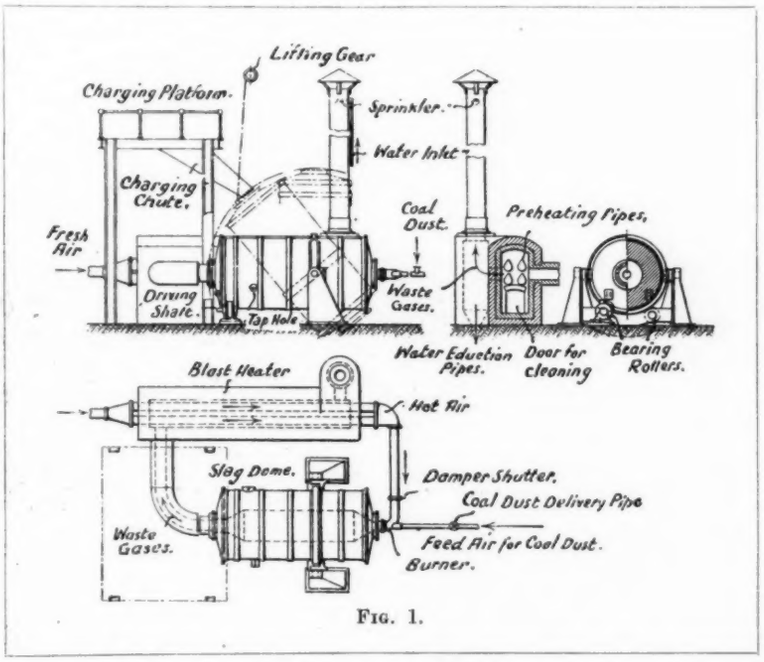


FIG. 1.

Fig. 1 shows the Brackelsberg furnace arranged for melting steel.

One essential feature of the Brackelsberg furnace is that the coal-dust flame enters the furnace directly and in such a way that the major portion of the ash carried along with the flame leaves the furnace again without in any way markedly affecting the melt. All the sulphur contained in the coal escapes from the furnace along with the ash. This process also embodies the great advantage of coal-dust furnaces—that is, that no large excess of air is required for obtaining perfect combustion. Due to this fact, flame temperatures can be obtained which closely approach the theoretical, and this makes it possible to work with a weakly reducing or at least a not very strongly oxidising flame, and one which has a sufficiently high temperature to melt the metal quickly.

During the process of melting, only a few rolling movements are made with the furnace for the purpose of continually bringing the coldest parts of the charge into contact with the flame, and so ensuring the material being uniformly and quickly heated. As a consequence, melting is carried out much faster than it is in the fixed reverberatory furnace having the same flame temperature, while the heat is utilised better owing to the greater temperature-interval between the flame and the colder part of the charge which is constantly being subjected to it. Due to the acceleration of the melting process, any considerable oxidation of the charge is avoided, especially when work is being done during this period with a slightly reducing flame. At the moment when the metal melts, the oxide adhering to it can easily segregate and pass over into the slag. At a temperature slightly above the melting point, iron only has a small capacity for dissolving oxides.

Immediately after being melted, the liquid metal is covered over by a slag, the formation of which is promoted by adding a little lime. During the further stage of the melting process, the metal bath is thus protected from the effect of the furnace gases by a dense covering of slag, which, however, is not thick enough to act as an insulator of heat. The metal comes into direct contact with the flame only while it is being melted down—at a time, that is to say, when the capacity of iron to dissolve gases is only very slight. Iron in the liquid state is much more able to dissolve gases than when it is in the solid state, and this dissolving power goes on increasing with rise in temperature. In the period in which the liquid iron is being superheated to the required casting temperature, *i.e.*, the period when it can absorb most gases, it is protected from the effect of the furnace atmosphere by the protective coating of slag.

Gas Absorption Minimised.

Due to the special conditions under which this process is carried out, the slag covering is not broken either by the bath boiling or by the violent reaction of the coal-dust flame on the bath, while the liquid metal is being superheated.

As no appreciable quantities of metallic oxides get into the bath while the iron is being melted, the bath does not boil up to any marked extent due to the carbon reacting with any oxides present in it. The reaction between the carbon contents of the bath and the metallic oxides is very quiet, and does not cause any metal to spurt up and so be still further oxidised.

Although the coal-dust flame develops with extraordinary rapidity, it is controlled so that it fills the free space of the furnace uniformly without impinging with all its force on the bath at any point and breaking through the covering of slag. The slag and the furnace walls absorb the heat and give it back to the metal, so that the flame does not react directly on the bath.

In the Brackelsberg furnace, the iron has therefore scarcely any opportunity of dissolving gases or oxides. Any oxides which get into the bath during the process of melting, and which remain in suspension because they cannot be dissolved at the comparatively low temperature, can settle in the slag. The finished alloys melted in this furnace consequently contain very little gases or dissolved or suspended oxides.

Differences from Cupola Practice.

As regards the features mentioned, this melting process differs widely from the processes usually adopted for melting cast iron. When iron is melted in the cupola it is impossible to prevent the liquid iron, which is in a state of fine division, dissolving gases and oxides from the furnace atmosphere and so carrying oxides in a state of fine division with it into the bath. The danger of obtaining an iron containing a high percentage of gases and oxides is a very real one in this process.

In the fixed reverberatory furnace the melting process is a protracted one, on account of the unfavourable transmission of heat to the portions of the charge not on the surface, so that it is possible during the melting period for the iron to become saturated with gases from the furnace atmosphere in the solid phase. With a view to utilising the heat better for the melting process, and preventing the rapid destruction of the furnace roof, the flame has to be lowered on to the bath, so that it is impossible to prevent direct contact with the bare surface of the metal. The portion of the melt which is subjected to the intense action of the flame is, owing to the high temperature, more soluble for gases which are transmitted by the flame to the metal at this point. This effect on the bath is specially marked in the oil furnace, where the comparatively small-pointed flame has an intense effect on the metal bath. Only in the electric furnace can a perfectly satisfactory iron be melted, but this process is, of course, not an economical proposition.

Character of the Iron Melted.

The difference in the way the iron is treated in the Brackelsberg furnace comes out in the behaviour of the iron after tapping, both in the ladle and while it is being poured. The iron remains perfectly quiescent in the ladle, and no gas bubbles are liberated from it. It behaves just the same in the mould. No wasters have been observed up to now due to blisters or other types of gas troubles. The tendency of the metal to draw is also less than in iron melted by other methods. The three trial castings specially liable to draw were all perfectly sound. The author cannot help thinking that the tendency of iron to draw might be connected in some way with the gas contained in the metal. This method of melting consequently enables an iron to be melted which gives sound castings throughout even in difficult sections.

A further characteristic property of iron melted in the Brackelsberg furnace is its extraordinary fluidity, which makes it possible to make casts in which the iron, after passing through wide and narrow passages in the mould, can still fill up very thin sections. It must be surprising to note that, in the case of iron melted in this furnace, previous experience has shown there to be no connection between the fluidity—or, to put it better, the casting properties—of the metal and its chemical composition. In making this statement, it is assumed of course that the degree of superheat above the melting point is the same. As regards the casting properties, practically the same high demands can be made of a cast iron containing about 2.5 per cent. C and 0.1 per cent. P as an iron containing approximately 4.0 per cent. C and a high percentage of phosphorus.

The fact that iron alloys melted in the Brackelsberg furnace are practically free from gases and oxides can be readily understood from the favourable conditions under which melting

is carried out. It is not so simple, however, to explain the connection between the extreme fluidity of the iron and the melting process. As to whether and in what way the viscosity of iron alloys is affected by a percentage of gases and oxides it is impossible to say definitely, in the absence of the necessary data. The following explanation may perhaps be near the truth: The purer a melt is, the greater its tendency to undercool. If the melt contains dissolved gases or oxides which segregate during cooling, this may prevent all possibility of the metal undercooling. In this case, the melt segregates the first mixed crystals at the proper time, so that the viscosity of the metal will suddenly increase as soon as the temperature of incipient solidification is reached. This fully confirms the findings of practice, which show that the difficulties of casting iron alloys increase considerably with decrease in the carbon content, obviously because the quantity of primary mixed crystals, and, at the same time, the temperature of incipient solidification increase. The poor casting properties of low-carbon cast iron would thus represent the normal case. In alloys free from gases and oxides, on the contrary, the segregation of the first mixed crystals would, due to undercooling, only commence at a much lower temperature than that corresponding to the temperature point of the liquidus curve; that is to say, the metal would be able to flow a much longer way in the perfectly liquid state than it would at the normal commencement of solidification.

Production of High Quality Castings.

Considerable progress has been made in Germany in the last few years in the production of high-quality cast iron, and scientific research

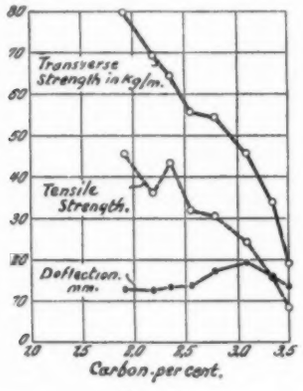


Fig. 2.

work has done a great deal to establish the fundamental conditions for the production of an iron having the best attainable mechanical properties. Above everything, this work has shown that as fine a division as possible of the graphite and a pearlitic ground structure should be aimed at. Systematic experiments confirmed an old bit of practical experience which says that this can best be done by reducing the carbon content. In the low-carbon alloys, the original graphite particles easily dissolve, thus enabling the graphite to segregate in a fine form from the nuclei-free alloy. At the same time, a purely pearlitic matrix is obtained automatically under normal conditions of cooling. It was found that, with a composition otherwise normal, the highest strength figures are obtained in alloys containing 2.5 to 2.7 per cent. of carbon.*

The application to practical conditions of the fundamental rules established by scientific research has been made difficult by the lack of suitable technical aids. The methods of melting, in particular, have been found to be in many ways insufficient and unsuitable for obtaining a cast iron possessing high mechanical qualities with the necessary certainty and uniformity and for bringing the metal into a state for giving ideal castings. Generally speaking, the difficulties which occurred when practical attempts were made to reduce the carbon content to 2.5 to 2.7 per cent. and cast the iron satisfactorily were such that the advantages of better mechanical properties had to be sacrificed and the carbon content raised again to more than 3 per cent. It was the same or similar reasons that reawakened interest in the United States for semi-steel which, developed about 20 years ago, was melted in the cupola from charges consisting of up to approximately 50 per cent. steel scrap.

The author has already referred to the cause of these casting difficulties, which are connected with the gases and oxides absorbed. It is not possible to diminish the percentage of gases and oxides by subsequently superheating the metal in the oil or electric furnace, as the dissolving capacity of iron increases with rise of temperature, so that the troubles may even be made worse where melting has been performed in a gaseous atmosphere.

High Temperature and Quality Castings.

These difficulties are eliminated in the peculiar process of melting adopted in the Brackelsberg furnace, so that cast iron containing down to

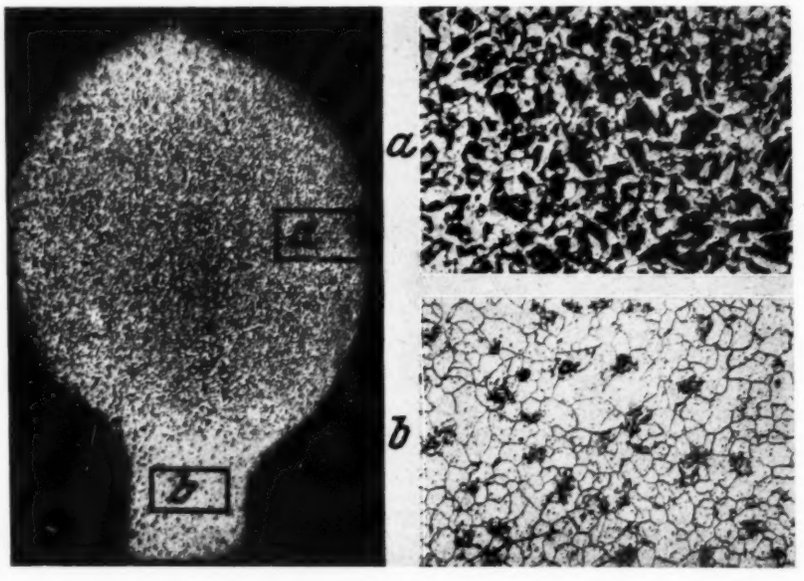


Fig. 3.

2.5 per cent. carbon and less gives saisfactory castings of very thin cross-section, quite independently of the silicon and phosphorus contents. No defects of any kind arising from the defective quality of the iron can be observed in the castings. The casting temperatures attainable in the furnace are extraordinarily high even where coal blast air is used, so that this furnace makes it possible to melt a high-quality cast iron of any desired composition and satisfactorily pour it into sound castings. The Brackelsberg furnace thus bridges a gap which has previously remained between the practical production of high-quality cast iron and advanced scientific research. The production of quality cast iron has thus been advanced a considerable step by the Brackelsberg furnace, as it enables the scientific knowledge hitherto gained to be applied extensively.

Twenty-eight Tons Tensile.

As illustrating the above statements, mention should be made of the results of a series of tests which the author published in a Paper prepared jointly with Dr. Zeyen.* Fig. 2 shows the effect of the carbon content on the mechanical properties of a normally cast iron containing approximately 3.5 per cent. Si. With decreasing carbon contents, the transverse and tensile strength of these alloys increase in practically a straight line, the extraordinarily high figures of nearly 50.79 tons per sq. in. and approximately 28½ tons per sq. in. being attained for the transverse and tensile strengths respectively with 2.0 per cent. of carbon. The deflection only drops off slightly with drop in the carbon content, being still 0.5 in. with approximately 2.0 per cent. C. Only by using a perfectly satisfactory method of melting is it possible fully to utilise these results on a practical scale; and this perfect method is afforded by the Brackelsberg furnace. Nor must we underrate the importance of this melting process for low-carbon alloyed cast irons, which promise still better results than the low-carbon cast iron containing higher percentages of silicon.

The possibility the Brackelsberg furnace affords of producing a low-carbon cast iron possessing very good casting properties will also be extremely useful in malleable iron foundries. The expensive malleable castings have practically only been able to maintain their superiority because high-carbon alloys have the advantage of giving very light castings that are sound. To get from them a low-carbon final product having as far as possible the mechanical properties of steel, the great excess of carbon must be removed at considerable expense by annealing.

Malleable Iron Melting.

The Brackelsberg furnace will considerably simplify and cheapen the malleablising process, as it enables the carbon content of the original castings to be lowered considerably without impairing the casting properties of the metal. With an iron melted in this furnace, and containing 2.5 per cent. and even less of carbon, practically the same thin-walled castings can be produced as with an iron containing 4 per cent. carbon. The less carbon the malleable castings contain, the quicker the annealing process is completed. Also, by reducing the carbon content, the silicon content can be proportionately raised without graphite segregating when the iron solidifies. A reduction of the carbon content of 1 per cent., for instance, means that the silicon content can be raised by about 0.6 per cent. This increase in the silicon content increases the rate of dissociation of the iron carbide, thus further curtailing the process. Experiments have shown that the malleablising process can be very considerably shortened by these precautions. The following test may serve as an example. Small keys with a stem diameter of approx. 0.12 in. were cast from an

* P. Bardenheuer and K. L. Zeyen: "Contributions to the Knowledge of the Graphite in Grey Cast Iron and its Influence on Strength," Mitt. Kaiser-Wilhelm Institute, Eisenforsch., 10, 1928, pp. 23-53; Giesserei, 15, 1928, pp. 354-65, 385-97, 411-20.

* Loc. cit.

iron containing 2.8 per cent. C. from a pattern plate. The keys were packed in fine annealing ore in a mild steel pipe and annealed for 3 hours at 900 deg. C. Fig. 3 shows the structure of a sectional surface of a key after this treatment. The thin parts have become completely ferritic, the thicker parts exhibit a little pearlite in addition to the ferrite. The grain of the structure is very finely developed. Even with heavier malleable castings, the malleablising process can be considerably simplified and curtailed in a similar manner.

Increasing the Use of Steel Scrap.

As regards the question of mixtures, it is possible, by selecting a low carbon content—especially where high-quality irons are being produced—to work up large quantities of steel scrap and thus reduce the cost of the furnace charge. The fact that the fluidity of iron has been made practically indpendent of the chemical composition means that the wide range of qualities which are now usually produced in the foundry can be confined to a few. Even were it necessary to use iron from one and the same melt for ordinary structural castings and high-quality steam cylinder castings, there would be no drawbacks either of a technical or economic character in doing so. In general, it would even be possible to restrict the qualities of cast iron to a *harder* quality with high strength figures, and a *soft* quality. It would even be possible to make both sorts from one and the same furnace heat by first casting off the higher-carbon soft castings and then adding steel scrap and ferro-alloys in order to get a harder quality in a short time.

Applying Research Results.

It should also be noted that the gates and broken scrap from the Brackelsberg furnace, being free from gases and oxides, are equal in value to the added material, and may even be superior in certain circumstances to a pig-iron of the same analysis. The Brackelsberg furnace constitutes, for ordinary and malleable iron foundries, a melting apparatus of simple design and easy to manipulate, and one which enables a high-quality iron exhibiting the best casting and mechanical properties to be produced at low melting and running costs from cheap charge materials. It therefore solves a problem which has an extensive bearing on the production of high-quality cast irons and its further development. The furnace has put the production of quality cast iron on a wide basis, due to the process being simplified and cheapened, so that we may count upon a general improvement in cast iron, including malleable iron. The almost daily increasing demands of the various branches of engineering for metals of improved quality have ruled out cast iron in many cases, due to its mechanical properties being insufficient, while in other cases its further use is questionable. Progress in research and in the production of high-quality cast iron has done a great deal to restore the prestige of cast iron as an important material for mechanical engineering, even with the high demands which are now being made of it; and the new process of melting is of very considerable importance in the solution of these problems. It cuts out serious defects which have hitherto been regarded as inevitable natural weaknesses of the material, but which were really only attributable to the melting process. The excellent quality of iron melted by a perfectly satisfactory process now shows clearly how backward the metallurgy of cast iron has been. The results obtained up to now with the Brackelsberg furnace indicate ways in which the metallurgy of cast iron can be developed to an equal extent to the metallurgy of steel. And so a new and vast field is opened for scientific research, and new problems arise on the practical side for further improving the quality of the products *pari passu* with the increase in scientific knowledge.

Scrap in Open-Hearth Furnace Practice.

More than one-half of Germany's production of steel is made from steel scrap and pig-iron. The price and quality of the scrap, therefore, assume a position of equal importance in open-hearth practice, with the corresponding price and quality of the pig-iron. It has long been recognised that open-hearth costs depend to some extent on the quality of the scrap, and at last at the instance of the Association of German Ironmasters (Verein Deutscher Eisenhüttenleute), and with the co-operation of several German plants, extensive experiments are being undertaken on an actual working scale, to study the effect of particular grades of scrap on operating costs, with the aim of arriving at a price scale for scrap which will vary with its actual value to the open-hearth operation. An open-hearth furnace is charged with a grade of scrap and the manganese consumption, hot-metal additions, lime needed, time of melt, etc., are noted. On the basis of a fixed price for pig-iron, the prices of the scraps are then adjusted to yield a constant operating cost per ton of steel produced.

In the experiments recently made by Herr Ernst Kerl at the Vereinigte Stahlwerke plant at Höntrop, on two 120-ton tilting furnaces, the following grades of scrap have been used:—(1) Block scrap, about 6 × 5 × 20 in., weighing about 180 lbs.; (2) clean sheet, bundled, about 36.5 × 30 × 30 in., weighing about 2,204 lbs.; (3) detinned sheet, bundled, about 18 × 16 × 6 in., weighing 176 lbs.; (4) clean steel turnings; (5) partly rusted steel turnings; (6) bought steel scrap. The results of the experiments, consisting of eight heats in the case of scraps (1), (2), (3) and (6), and two heats in the case of (4) and (5), are shown in Table I. The two furnaces were fired with a mixture of coke-oven gas and blast-furnace gas.

Table I.—*Effect of Various Grades of Scrap on Open-Hearth Results.*

Kind of scrap.	(1)	(2)	(3)	(4)	(5)	(6)
Per cent. of metallic charge	78.34	66.68	55.26	74.40	77.04	70.68
Total average metal charge, in tons	125.258	133.495	138.701	133.471	136.731	125.527
Charge in lbs. per ton of steel made—						
(*a*) Scrap	1834.12	1650.31	1384.28	1824.59	1905.20	1659.41
(*b*) Pig (molten)	478.65	717.18	1028.67	516.30	477.44	640.33
(*c*) Pig (cold)	14.98	34.25	48.51	33.06	48.20	14.89
(*d*) Swedish ore (68 per cent. Fe)	14.10	6.07	28.01	64.75	30.42	14.04
(*e*) Ferro-manganese 73.5 per cent. Mn	7.61	9.81	12.71	12.41	8.23	10.54
Total	2349.46	2417.62	2502.18	2451.11	2469.49	2339.21
Time of melting, in min.	360	372	392	340	432	310
Time of boil, in min.	375	394	427	388	488	330
Total time of heat, in min.	473	468	517	554	611	450
Ingot yield, per cent. of total metal charge	93·58	90.94	87.87	89.79	88.97	93.0
Ignition loss, in per cent., total metallic charge	4.24	6.38	9.64	7.37	9.26	4.54
Coal consumption in lbs. per ton of steel	328·9	315.9	333.0	361.9	411.4	319.4
Lime used in lbs. per ton of steel	32.5	35.9	69.3	74.1	87.2	33.0
Dolomite used in lbs. per ton of steel	36.6	36.6	36.6	36.6	36.6	36.6
Wear of furnace	Normal	Normal	Badly damaged			Normal

Table II.—*Price of Scrap, Marks per Ton.*

Pig-iron per ton.	65 mks.	74 mks.	90 mks.
	Mks.	Mks.	Mks.
(5) Rusty turnings	51.50	48.50	44.50
(3) Detinned sheet	49.50	42.00	29.50
(2) Clean sheet	56.00	51.50	44.50
(6) Steel scrap	56.00	52.50	46.00
(1) Block scrap	58.50	56.00	52.00

On the basis of the above data, the value of the different grades of scrap was determined, and the prices then fixed to yield a constant operating cost. The results of such an evaluation are to be seen in Table II (applied to German practice). Clean unrusted steel turnings, at a price of 54 mks. per ton at a pig-iron price of 65 mks. per ton, are used as the basis for this calculation. With a pig-iron price of 74 mks. per ton the cost of the clean scrap was not to exceed 51 mks., and with pig-iron at 90 mks. per ton the clean scrap had to be as low as 46 mks. All tons in this article are metric tons.

The pig-iron was, whenever possible, charged into the open-hearth furnace in a molten state, and was of the following average analysis:—C, 4.42; Si, 0.57; Mn, 3.77; P, 0.138; S, 0.03; and Cu, 0.15 per cent. The scrap was nearly throughout mild steel carrying about 0.08 per cent. C, and 0.40 per cent. Mn, except the turnings which had a carbon content of 0.25 per cent. and 0.68 Mn.

Catalogues Received.

Melting Plant.—We take it that the issue of a leaflet dealing with the Poumay system of cupola control by the Constructional Engineering Company, Limited, of Titan Works, Charles Henry Street, Birmingham, is an announcement that this firm is now responsible for both the sales and manufacture of the plant. The scheme has been to utilise the interior for a clear and concise statement of the claims for the Poumay system, whilst the back contains four authentic testimonials from prominent users. An improvement could be effected by underlining phrases in the testimonials which substantiate the claims. If this had been done the number of claims could have increased to six, as one letter states that less patching is used, but to counterbalance this no user confirms that the metallic losses are lower. Despite this suggestion the leaflet is a very creditable piece of publicity.

Fans.—The catalogue VI, just issued by James Keith & Blackman, of 27, Farringdon Avenue, London, E.C.4, possesses as the best features of what a production of this character should carry. It is well arranged, adequately illustrated and filled with technical data of the type which reduces the work of the purchasing engineer to a minimum. We would have expected that a code word would have been given for each size, but evidently *experientia docet*, for, to quote the preface, "the proper application of fans is a science in itself, involving careful consideration of the prevailing conditions, objects to be achieved, the correct relationship between the means of ingress as well as the expulsion of the air." Herein we suspect the reason for the exclusion of any code. There are 38 pages in this new edition, and we advise our readers to procure a copy for filing purposes.

Messrs. Vickers, Limited, officially announce that a report of negotiations proceeding between the company and the Soviet Government for a specific contract to the value of £15,000,000 is incorrect. A representative of one of the Vickers associated companies—the English Steel Corporation, Limited—is at present in Russia seeking orders in the ordinary course of business, it is stated, but the company has no knowledge of any unusually large order and the representative has no power to arrange credit terms.

Plastic Linings for Cupolas.

By G. H. Zirker, Dr. Eng.

(*Translated and condensed from "Die Giesserei."*)

The method of operating cupolas in iron foundries has undergone practically no change for the last 50 years. Now, as then, a standard cylindrically-lined shaft furnace with one or two rows of tuyeres is used in most cases, while variants in the standard designs that have been introduced in the last 30 years have not proved sufficiently successful to affect the technical and economic operation of iron foundries. The only alteration in the actual operation of cupolas probably consists in the use of plastic material for lining the furnace in place of the radial refractory bricks that were introduced many years ago.

As far as the author is aware it was not until 1921 that wide publicity was given to the possibility of adopting rammed plastic masses for cupolas, and that was at the Foundry Exhibition at Munich, where a model of a rammed-out cupola was exhibited. The adoption of these rammed plastic linings for cupolas made such headway that it is now estimated that approximately 60 per cent. of all the German iron foundries now ram out their cupolas instead of bricking them.

An Efficient Investigation.

In the year 1925, the German Association of Foundrymen and the Union of German Iron Foundries took up the question by appointing a Committee to investigate the possibilities and advantages of rammed linings as compared with brick linings, and the foundries were invited to collaborate on the practical side of the question. Unfortunately, as far as practical foundrymen were concerned, this appeal fell on deaf ears, and the results of the investigations carried out in 1925-26 are crystallised in the report of the Committee that was published at that time.* This report contains the results of tests carried out at three iron foundries on four different plastic linings. The substance of these results is that a consumption of approximately 2 per cent. of dry lining composition is to be expected, referred to the iron charge put through the furnace; and this means a consumption of approximately 2½ per cent. of the ramming compound in the state in which it is delivered. This figure agrees with various ascertained figures for the average annual consumption of lining compounds in large foundries which have come to the author's knowledge. These figures varying usually between 2 and 3 per cent. of the iron throughput. In view of the small amount of co-operation afforded by the foundries, the results are meagre and unsatisfying, and this fact led the German Ironfoundry Owners' Federation to frame the following resolution in June, 1928: "Resolved that the question of plastic lining compounds be shelved for the present, owing to the disproportion between expenditure and anticipated results."

The general experience gained by the writer over roughly six years with various plastic linings cannot, of course, pretend to be complete, yet it admits of general considerations and conclusions, which will be discussed in this article.

Usual Composition.

As regards chemical composition, the plastic refractories used for lining out cupolas exhibit an analysis fluctuating between the following approximate figures:—85 to 95 per cent. silica, 5 to 15 per cent. alumina, and 1 to 2 per cent. lime, magnesia, the alkalies, and occasional traces of ferric oxide and titanic acid. The loss due to heating varies between 2 to 4 per cent. The materials may, therefore, properly be regarded as clayey sands. The refractory index varies between Seger cones 30 and 34.

Neither the chemical composition nor the refractoriness alone is sufficient guide to the quality or usefulness of a ramming mass for cupolas. A proper knowledge of its properties can only be gained by studying the processes in the cupola in their bearing upon the furnace lining.

There are three distinct sections in a cupola lining: the lower portion from the spout to the first row of tuyeres which takes the fuel coke and collects the molten iron—also termed the "well"; then the melting zone proper, beginning at the tuyeres and usually extending 12 to 16 in. above them; and, finally, the shaft up to the opening of the throat, this portion being used merely to pre-heat the iron charges.

In a carefully-operated furnace, the lining—usually cylindrical or slightly profiled—at the throat is subject to mechanical wear by abrasion due to the charges of iron and coke thrown into it. In the melting zone the furnace lining has the greatest strain thrown upon it, due to (1) the melting temperature, varying from 1,600 deg. C. upwards, and (2) mainly to the chemical effects of the slag formed by the impurities in the iron and the coke, in conjunction with the limestone or fluorspar used as a flux. In the well, the lining comes under the dual influence of the burning coke and the molten iron with its slag covering.

A cupola operated in the ordinary way presents the following picture on the day after a melt or melts have been made, as determined by the effects, etc., mentioned above. Very little of the lower portion of the lining has suffered from the heat; it is perfectly cylindrical, and there is very little increase in diameter compared with the original state. The tuyeres themselves should be open and free from residual slag deposits. It is immediately above the tuyeres, beginning at a distance of some 6 in. above them that the loss by heat is most marked, this effect continuing to a decreasing extent to 12 in., or at most 16 in. above the tuyeres into the upper portion of the lining. The upper part is, comparatively speaking, only attacked to a slight extent, and assumes a slightly conical shape from bottom to top until it reaches the radial or chromite iron bricks below the opening of the throat. If the furnace has been properly operated and there has been no "sticking," it is usually burnt evenly all round and certainly does not exhibit any holes which might lead to the furnace "giving" at the lining.

German Cupola Practice Irregular.

The writer recently had the opportunity of inspecting 50 cupolas—in addition to his own—installed in approximately the same number of foundries—when he found, to his regret, that many of the furnaces inspected did not exhibit the normal condition as outlined above, either due to carelessness in carrying out melting operations, because the melters were not properly supervised, but partly due to work not being carried out on a proper system. One of the chief sources of error in cupola operation is often due to the arrangement of their tuyeres and their dimensions and the blast volumes or velocities, and/or pressures adopted—points upon which foundrymen are far from being in agreement. A further fundamental evil observable in many cases is the excessive amount of limestone or even fluorspar added, this frequently not being estimated, and usually never measured or weighed. It is perfectly clear that excessive flux puts an unnecessary strain on any furnace lining, quite apart from the metallurgical side of the question. Foundry executives ought in many cases to devote greater attention to the proper operation and supervision of the furnace itself, instead of only thinking about the composition of the mixtures. A curious situation is created by firms obviously out to produce high-quality cast iron whilst neglecting the simplest metallurgical rules in operating their cupolas. Rammed plastic linings should exhibit the following properties:—High refractoriness, at least 36 Seger cone; high mechanical strength; and high resistance to chemical influences. But even these positive qualities are not sufficient of themselves to judge a good lining compound. There are other properties depending upon the way the material is applied and treated.

First of all, the material must be capable of being rammed easily and properly, *i.e.*, it must compress compactly so that the resultant lining is uniform—without joints—as it is this factor, of course, that constitutes one of the undisputed advantages of rammed linings. This means, then, that the grain should not be too coarse, as coarse grains increase the surface and afford bigger areas of attack for chemical influences. But if, on the other hand, the grain of the material is too fine, it is disadvantageous, because the steam which escapes when the lining is drying cannot find an outlet, and the new lining would peel off in places.

Behaviour when Subjected to Heat.

In addition to the high refractoriness, it is particularly desirable that the "sintering point," *i.e.*, the point at which the material burns hard, should be as low as possible. Unlike bricks, rammed linings cannot be burnt, so that the wall of the lining should take on a smooth glaze due to the effects of the maximum temperatures, so that the charges can slip down it without sticking. The inner layer should burn perfectly hard, so that the annular rammed-out furnace forms a large brick from top to bottom and does not "powder," because, if it does, the furnace lining is likely to suffer badly if the glazed layer is broken, as it sometimes unavoidably is. Unfortunately, not all ramming compounds have completely satisfied this requirement, because it is apparently just as difficult to obtain the dual combination of high refractoriness and low sintering point in rammed materials as it is in bricks.

Lastly, plastic linings must exhibit a high degree of plasticity, as a certain binding capacity is required when working with them. This point also has an important bearing in connection with repairs to the lining, although, of course, repair work is frequently carried out with materials that contain more clay.

It is impossible to ascertain the essential requirements in the laboratory, practical experience being necessary in the shape of observations on furnace linings that have been rammed with the materials it is desired to test.

All tests in this connection should, however, be made with special observance of the conditions under which rammed linings have to do their work, and a certain amount of actual experience is necessary to achieve satisfactory results. All the cases of failure with rammed (plastic) linings as compared with ordinary masonry linings are due either to the conditions not having been properly observed—either intentionally or unintentionally—or to want of experience.

Practical Operating Details.

The differences in the various types of linings as regards their use are so slight that a little experience will soon enable the worker to adapt himself to the method of working with the several variations of type. The material used for ramming out a cupola must be uniformly fine. Hard and lumpy pieces must be avoided, and, where present, they should be broken up and the material edge-milled before being used, if necessary. Rammed materials are supplied either as natural products or as mixtures of two or more ingredients. Generally speaking, the

* "Die Giesserei," vol. 13, p. 547.

natural product has the advantage of uniform composition, whereas, in the case of mixtures, the foundryman has to depend upon the care or otherwise of the firm supplying the materials. Where mixtures are used, it is always possible for the components to become separated while the material is being transported from the pit to the point of consumption, or to be washed out by rain. The practice adopted by some foundries of making the mixtures themselves is to be deprecated, because experience has shown that the proper uniform composition cannot be guaranteed. Any saving in first cost is lost due to unavoidable troubles in the cupola.

Ramming materials are usually too dry in the state in which they are supplied, especially as it is impossible to prevent losses of moisture due to evaporation during the transport and storage of the material. The material should be neither too wet nor too dry when it is being rammed. A handful of the mass should not soil the hand, otherwise it is too wet and will stick to the rammer; and two lumps of the material should adhere lightly without coming apart when the pressure is removed. If they do not, the material is too dry and the necessary binding capacity of the particles is absent and the proper state for compression is impossible. After a little practice the men engaged in this work can tell instinctively whether a material is correct or not, and there is comparatively little risk of errors under this head. When it has to be used for making repairs, the material needs to be wetter. A lump of material thrown on to a wall should stick there and not fall off.

Finally, it is necessary to have a sort of "size," or a thin paste of ramming compound, which is made by rubbing up the thick paste with water, the fingers being used for this operation. As a general rule, the material to be used should be prepared at least 24 hours beforehand, so as to get a uniform dampness.

Ramming Details.

Before ramming out a furnace, the old furnace lining, whether masonry or rammed mass, must be removed, but a brick-on-edge course of refractory bricks may be left as a jacketing layer. The only thing to observe carefully is that the new rammed layer is at least 8 to 10 in. in thickness. The old jacketing layer that is left must then be coated with the "size" or thin paste to ensure a satisfactory joint between the old layer and the new lining. A ramming template is required for the ramming operations, its outside diameter being the same as the inside diameter of the furnace. A thick iron ramming ring can be used, fitted with turn-buckles to enable the ring to be contracted from the maximum diameter to 2 in. less diameter. This ring should be 16 to 20 in. high. Instead of the iron ring, which should be made of stout sheet iron and suitably stiffened to prevent its giving under the blows of the rammer, a wood template can be used. This should be made preferably in three sections, of hard wood, and should taper slightly downwards. To each section, pull-rods with lugs should be fitted so that the entire template can be easily withdrawn by hoisting tackle.

Tools Used.

It is better not to make the wood template solid, but to have an opening in the middle through which a bucket or tool can be passed. The edge of the template must be wide enough, however, for a man to stand upon easily. Before being used, the iron ring or wood template must be properly oiled to prevent the ramming compound sticking to it. Hoisting tackle (pulley blocks, etc.) is suspended from a U-iron section or a solid wood beam at the throat of the furnace to enable the rammer ring to be drawn upwards. The ring or the wood template is inserted either through the throat opening or the drop-doors at the bottom, which must remain open while operations are proceeding. The workmen enter the furnace by the same means. The iron ring is then brought to the correct dimensions or the wood template secured to the joints by means of wood wedges driven in. Care should be taken to see that the ring is situated truly in the middle of the furnace, *i.e.*, that an even layer of rammed material can be applied round about it.

Before the actual work of ramming is commenced, the old brick-on-edge course is covered with the thin "paste," which must be thoroughly stirred up before being applied. The lining material proper is then introduced in buckets either through the charging or the bottom door of the furnace, and applied around the ring to a height of 2 to 2½ in. Iron rammers are used for compressing the material, and these must not be too heavy, otherwise the workmen are tempted simply to utilise the weight of the rammer to do the work, whereas uniformly compact ramming is essential to the success of a rammed lining. By far the most of the so-called failures in rammed furnaces are due to the material not having been properly rammed home. As to whether pneumatic or hand rammers are preferable is a point that depends upon the percentage of clay contained in the ramming compound. In some cases hand-ramming is better. More recently, this work has been performed with red-hot iron stampers, as these have the advantage of evaporating a portion of the water from the material during ramming operations and thus enabling a higher degree of compression to be obtained, and they prevent the material sticking to the rammer. The iron ring is now compressed into the smallest possible dimensions by means of the turn-buckles and then hoisted up by the hoisting tackle. If the wood template is used, the wood wedges are knocked out, the three separate sections raised and the wood wedges reinserted, or the iron rings set back to the original dimensions by means of the turn-buckles. The advantage of the iron ring is that it makes it an easy matter to shape the lining properly where the profile of the lining has not to be cylindrical. The ring or the wood template is preferably extended to only two-thirds of its height, the last third being inserted in the rammed material, as this prevents the previously rammed material being forced out below the ring when further ramming is carried out. The ring is rammed and raised successively in this way up to the desired height at which the iron chromite bricks are to be placed below the throat opening. It is advisable to make air-holes at intervals of, say, 1½ in. to 2 in. for carrying off water-vapour, these holes being made with the sort of pricker used by moulders. The tuyere openings are obtained by inserting suitable wood templates around which the material is carefully rammed.

Drying Out.

In addition to uniform ramming, an important part of the work is to see that the lining is properly dried. It will be readily appreciated that special stress must be laid on this part of the operation, because the lining cannot be "pre-burnt" like a bricked furnace can. Drying should remove not only the water admixed with the lining, but the chemically combined water as well. Care should be taken to see, then, that the heat applied is as uniform as possible and that it ascends slowly and steadily to all points of the lining.

After the coke has burnt out, *i.e.*, after the furnace has been dried out for about 20 hours, an examination should be made to see whether there are any bad cracks in the lining. If drying has been done carefully and slowly and the material rammed was not too wet, or, briefly, if all the working directions have been properly carried out, large cracks cannot occur. If, however, cracks have developed, they should be carefully sealed up with the soft repair material. It is advisable to blow in a newly-lined furnace for one hour with coke and blast—a job which many foundries do more or less every day. This produces a surface sintering of the lining, and is an advantage for the subsequent melting process, as this sintered layer protects the lining underneath it from abrasion set up by the charging of the iron. The operator must, of course, remember to replace the burnt fuel coke before starting a heat.

Repair Work.

Repair work is usually performed in the following sequence, usually the day after a melt has been made. As soon as the furnace is cold enough to allow a man to enter, any traces of iron and slag that have stuck must be carefully chipped off. Care must be taken not to injure the glazing or remove it. This glazing protects the layer below it from premature wear by burning, quite apart from the fact that the charges of iron slip down more easily on a glazed surface. Before repairs are made with the plastic material, the surface to be treated should be painted with the thin paste referred to above. The repair material should be ready to hand, and it should be free from lumps and be quite homogeneous. It is tightly compressed in the hands and pressed firmly on to the surface lining. This material can be either pressed home with the flat hand or with a wooden mallet, according to its porosity. The patch should extend well around the spot that has burnt out. Any holes that have formed in the lining require very careful and firm patching. As was stated above, a properly operated furnace only needs patching in the melting zone, repairs above and below this zone being exceptional. Nor is it necessary to continue the patching in the melting zone until the lining there has resumed the original cylindrical dimensions as this portion can recede slightly, as experience has shown that a slight widening of the furnace in the melting zone takes place automatically in every cupola. It would only mean an unnecessary waste of material, which would have to burn away when the next melt was made in the furnace. Occasionally, repairs can be made as follows, when the furnace is still hot, as it generally is when two furnaces are not operated alternately. Material, compressed in the hand, is thrown on to the hot walls of the furnace much in the same way as plaster is put on a wall. If the material is sufficiently "binding" due to the percentage of clay and the fairly large amount of moisture in it, it will stick of itself when applied. These slight modifications in the method of working are largely a matter of practice, and depend in every case on the skill of the man who does the job.

Selection of Staff.

It should not be difficult to show, on psychological grounds, that a skilled bricklayer is not always the best man for this work, quite apart from the fact that he must be paid higher wages. It is always best to detail for this job one of the cupola hands most familiar with the processes in the furnace, provided, of course, his other duties leave him sufficient time. Even large furnaces with a big throughput can be repaired in 1 to 2 hrs. when the furnace is patched up every day after a melt has been made. It is not wise to operate the furnace two or three days in succession without repairing it, because it is obvious that the heat of the furnace acting on the lining each day will weaken the lining, for it must be remembered that the patched places are not as sound as the rammed material, nor are they so resistant as the sintered layer of rammed material below them, as they have not been subjected to any special drying process.

It should be the invariable rule to have a responsible person—preferably the melter—measure the loss due to heat every day with a tape measure, and enter this information in the daily report of melting operations, just as the number of charges, the weight of the iron and coke, etc., are entered. The works manager or his assistant ought also frequently to check the

furnaces over to ascertain the extent of "wastage" in the lining.

Every foundry should periodically ascertain the consumption of ramming materials by the following simple method. When a furnace has been relined, the above measurement of the wastage due to heat should be made, as above, after the first melt, and the amount of material—in the ready prepared state—required for a repair carefully weighed, this work being repeated on three to six melting days. On the last of these test days, the furnace should be patched until it reaches the original cylindrical dimensions, and the weight of the material required for this job carefully noted. The weight of the plastic refractory used on these days, referred to the amount of the iron charges on the same days, gives the percentage of lining material used. These checks, when frequently repeated, afford useful information as to the way the furnace is being operated and the quality of the material used for lining.

Results Obtained.

The following results are from four different iron foundries, and, to ensure uniformity, the tests were taken on non-receiver types of furnace, the same material and methods of working being employed to enable comparisons to be made. The figures show the size of the furnace, the throughput, and the duration of casting affect the "wastage" of the furnace lining.

Test No.	Inside width at level of tuyeres.	Average amount of metal melted per hour.	Average amount of metal melted per day.	Average daily period of melting.	Consumption of lining material per 100 lbs. of iron charge.
	In ins.	Tons.	Tons.	Hours.	Lbs.
A ..	32	4	8	2	1.20
B ..	33 to 36	5	25	5	1.05
C ..	36 to 40	6	54	9	0.90
D ..	44	7	70	10	0.60

Furnace A was installed in a general jobbing foundry making light machinery castings, mostly from machine mouldings. Case B refers to a large iron foundry engaged exclusively in the production of castings for the electrical industry. In foundry C, dealing mainly with pipes, whilst in the last case, D, the furnace was used mainly for casting ingot moulds.

In all cases, with the exception of the pipe foundry, a very hot type of iron was melted with the addition of steel. The temperature fluctuated between 1,350 and 1,400 deg. C. and the blast pressure between 16 and 24 in. of water. It was not possible to estimate the blast volumes by means of apparatus. Taking the average of the above four results, it gives a lining consumption of approximately 0.9 per cent. of the iron throughput. It should be noted, however, that, due to careful observance of all the proper working conditions, the "wastage" of the lining was only marked in the zone of melting, this part of the furnace being repaired daily, if necessary, with the same material as was used for lining the furnace originally.

It was originally thought that higher throughputs and longer periods of melting adversely affected the consumption of lining material in terms of throughput, whereas, actually, an increase in the throughput and the period of melting is a favourable factor in regard to the consumption of lining material. This point is a very important one, in view of the fact, as continuous methods of operation are being introduced into foundries, the dimensions of the furnaces are lower than they were previously and the period of melting will be practically fixed at eight to nine hours, and continuous casting calls for uniform heats with a minimum amount of slag and, hence, reduced wastage of furnace lining.

New Design of Hot-Metal Ladles.

In the course of an article in a recent issue of "The Iron Age" a new design for hot-metal ladles is described, for which many advantages are claimed. The design, which was developed by Mr. F. F. Kling, chief engineer of the Youngstown works of the Carnegie Steel Company, has been successfully applied to ladles of 70-ton capacity. The new ladle, which is in operation at the above works for transferring hot metal from the blast furnaces to the mixers, aims at reducing to a minimum the radiating surface of the hot metal. A number of these ladles are being introduced at the Mingo, Ohio, works of the Carnegie Company, and others are being built for a Canadian steel company. As shown in Fig. 1, the shape of the ladle represents a decided departure from the usual type, and the centre of gravity of the metal is low. Splashing in transit is practically eliminated. The ladle is of strong construction and comparatively light in weight. It can be lifted from the car in pouring, or can be poured directly from the car, and a transfer ladle is unnecessary in pouring the hot metal into the mixer.

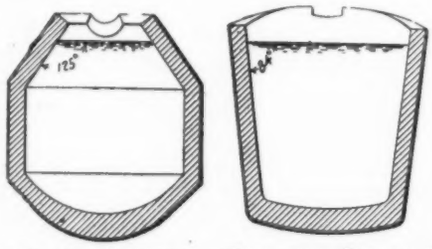


Fig. 1.—Sections of Kling and Ordinary Ladle of Equal Capacity.

Ladle trunnion bushings rotate on the self-lubricating brass sleeves, thus preventing wear on the trunnions, as well as on the crane hooks. Self-lubricating bushings have been provided also on the pin which the auxiliary hook of the crane, or the hook of the pig-casting-machine hoist, engages when turning the ladle over. The ladle car is of substantial construction and, because of its shortness in proportion to capacity, requires little track space. The car frames which tie the trucks together are made of 6-in. by 15-in. rolled-steel slabs of high tensile strength. Self-lubricating brass washers are used on top of the centreplates of the truck bolsters, reducing wear at this point and enabling the trucks to turn easily when going around curves.

The Kling ladle (as it is known in America) and car may be used satisfactorily on 85-lb. rails, and trestles of usual design are strong enough to support it. Kish removal is accomplished by dumping into a box or cinder pot immediately after the iron has been poured into the mixer; it does not have to be scraped out of ladle. Another advantage is that new lining may be put in without the use of arch supports.

In comparison with the old type of ladle, the Kling type keeps the metal hot longer, and runner scrap and scrap-ingot moulds can be melted in the ladle. With hotter iron the mixers do not skull, and considerably more scrap can be used in the converters. Skull in the ladle is practically eliminated, with the exception of a small growth of kish in the spout, which is removed about twice a week. Fewer men are required to manipulate and attend this type of ladle.

Messrs. Cochrane & Company, Limited, Ormesby Ironworks, Middlesbrough, completed a contract recently for the supply and delivery of 4,000 tons of 18-in. dia. cast-iron pipes and specials for the Municipality of Port Elizabeth, South Africa, for waterworks improvements. The contract also includes steel pipes, which will be supplied by the South Durham Steel and Iron Company, Limited, West Hartlepool.

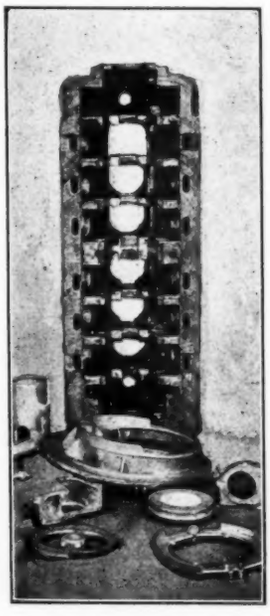
Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Large Light Alloy Castings.

To the Editor of The Foundry Trade Journal.

Sir,—Some time ago you conducted through the columns of your Journal a discussion on the subject of the largest aluminium alloy castings produced in Great Britain. May we draw your attention to the fact that we are now producing in our foundry a marine type six-cylinder crankcase casting in 12-per-cent. modified aluminium-silicon alloy, which casting we believe to be the largest of its kind produced in any British foundry.



From the photograph you will observe the intricate nature of the casting. It weighs 268 lbs., and is 4 ft. 8 in. long, 15¼ in. deep and 20 in. wide.

Under physical test the test-bar from the casting illustrated gave an elongation of 14 per cent., with a tensile reading of 14 tons per sq. in.

Foundrymen will readily appreciate that this is a very difficult alloy in which to produce castings which are perfectly sound and free from blowholes, and we feel sure that our achievement in successfully producing an intricate casting of this size will interest your readers.—Yours, etc.,

S. M. Wilford, Director.

(For and on behalf of
W. H. Dorman & Company, Limited.)

Stafford, August 31, 1929.

Reports and Dividends.

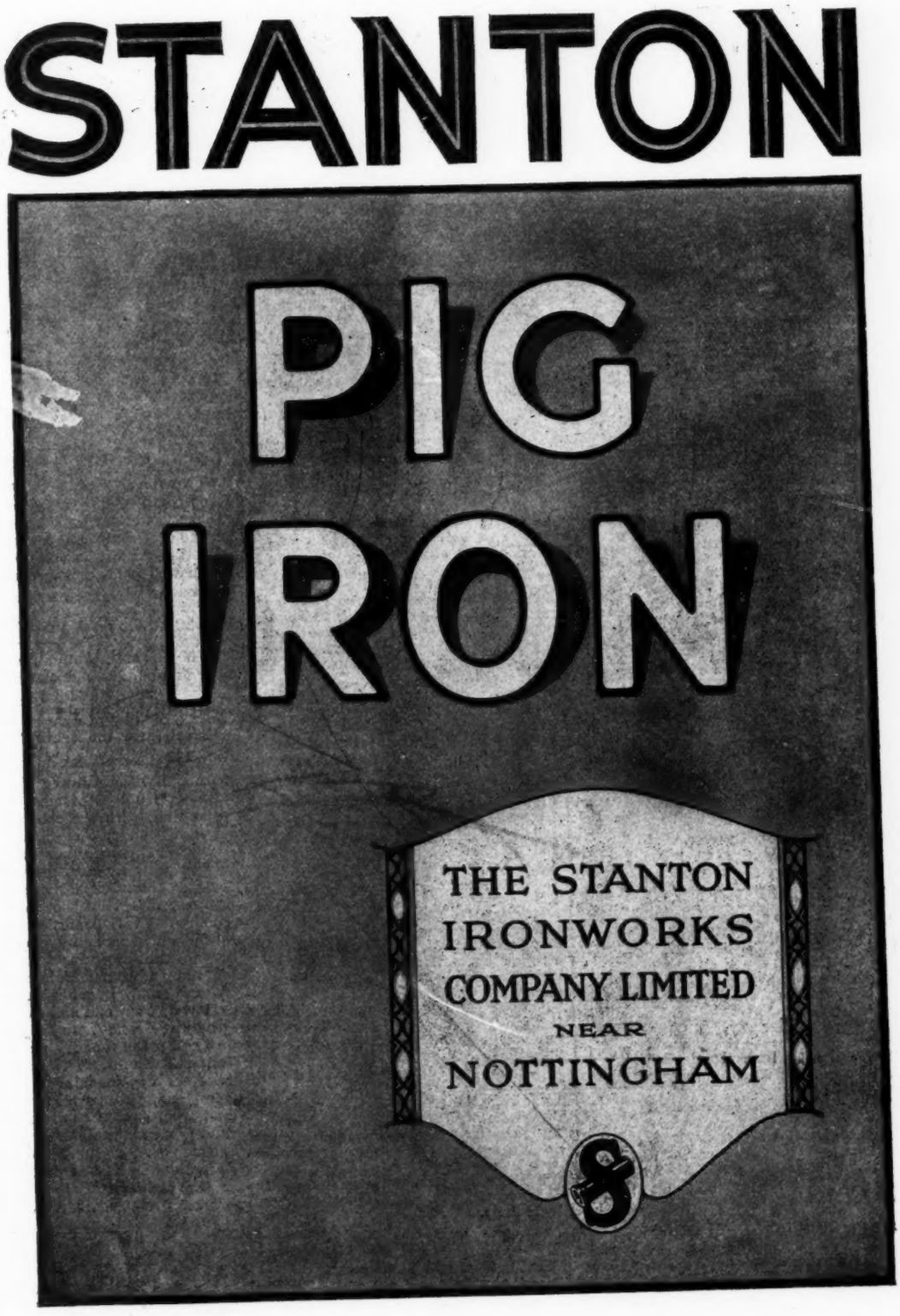
Clarke, Chapman & Company, Limited.—Interim dividend of 3 per cent., less tax, on the ordinary shares.

Dalmellington Iron Company, Limited.—Final dividend of 1s. per share on the ordinary shares, making 1s. 6d. per share, tax free, for the year.

Cammell Laird & Company, Limited.—The directors are unable to recommend the payment of an interim dividend on the preference shares.

Wm. Roberts (Tipton), Limited.—Profit, £1,705; brought in, £2,628; one year's dividend on the cumulative preference shares, £1,680; carried forward, £2,654.

Henry Hope & Sons, Limited.—Profit, £46,246; brought in, £45,605; final dividend of 5 per cent. on the ordinary shares, making 10 per cent., tax free, for the year; carried forward, £47,601.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Trade Talk.

The millmen at the Gorseinon Tinplate Works have returned to work, and operations were resumed last week.

The refinery at the Ridder lead mines, in Kazakstan, Russia, was destroyed on September 3 by fire.

An order for thirty 40-ton side-discharging wagons has been placed with the Birmingham Railway Carriage and Wagon Company, Limited, by the L.M.S. Railway.

Italian steel manufacturers have formed a cartel to lower costs by means of rationalisation and specialisation in production. The Government has approved of the enterprise.

The "Deputy Georges Chagne," which arrived at the Grangemouth docks with 3,000 tons of iron ore, was discharged in 16 hours. The s.s. "Soangen" was discharged of 1,500 tons of iron ore in just under seven hours.

Bell's Asbestos & Engineering Supplies, Limited, have removed their chief offices from Southwark Street, London, S.E.1, to their new works at Slough. The firm's head office address is now Bestobell Works, Slough, Bucks.

Messrs. Edgar Allen & Company, Limited, Sheffield, have completed a contract for Portland cement manufacturing plant for the Chinnor Cement and Lime Company, of Chinnor, Oxfordshire. The new works replace a smaller plant started in 1921.

A group of Soviet scientists, including several prominent engineers and technicians, have left for Tokio to participate in the International Engineering Congress and the fourth session of the International Power Conference to be held there.

The Albion Motor Car Company, Scotstoun, Glasgow, have secured from the Government of India a contract worth over £200,000 for 190 six-wheel three-ton vehicles, designed for cross-country work, as well as ordinary road transport.

The winning Supermarine machine in the Schneider Trophy Contest is a product of Vickers, Limited, the builders and designers being the Supermarine Aviation Works, Limited, the whole of the capital in which is held by Vickers (Aviation), Limited.

Messrs. Alloy Welding Processes, Limited, Ferry Lane Works, Forest Road, Walthamstow, London, E.17, have again secured the contract from the Admiralty covering the supply of A.W.P. Electrodes during the period from July 1, 1929, to June 30, 1930.

Messrs. John Lewis & Sons, Limited, Aberdeen, have launched the coasting steamer "Firecrest" from their Torry yard. The vessel, which is 160 ft. long and 26 ft. 6 in. moulded breadth, has been built to the order of Messrs. R. & W. Paul, Limited, Ipswich.

Messrs. Workman Clark (1928), Limited, Belfast, have launched the "Lidenbank," which is the fourth of the eight cargo vessels they have on order for the Bank Lines, Limited. The vessel, of 5,000 tons gross, will be fitted with direct-acting inverted quadruple-expansion engines by the builders.

The Vereinigte Stahlwerke A.G., Düsseldorf, Germany, has received a contract from the Russian Government to supply all ship plates and structural material needed by the Russian shipyards during 1930. The building programme of these yards is reported as eight to ten vessels.

The Ardrossan Dockyard Company, Limited, recently launched the single-screw cargo vessel "Blairsprey," built for the Northern Navigation Company, Limited, Glasgow. The vessel will be fitted with machinery designed for a speed of 11 knots by Messrs. John G. Kincaid, Limited, Greenock.

The Grangemouth Dockyard Company, Limited, Grangemouth, have launched the passenger and cargo vessel "Islander," which has been built to the order of the Christmas Island Phosphate Company, Limited, London. Twin-screw triple-expansion machinery is being supplied by Messrs. Plenty & Son, Limited, Newbury, Berks.

It is stated that the Austin Company of Cleveland, U.S.A., has been awarded a contract by the Russian Government for the construction of an automobile plant at Nishni-Novgorod. The plant, including foundry and power house, will cover a 5,000-acre site, and will be designed to manufacture 100,000 Ford motor cars annually.

On the eve of the departure of the British Economic Mission for Uruguay, Mr. Julian Piggot announced that British steel would soon be available in Argentina at competitive prices, although for several years past it had been virtually out of the Argentine market owing to the more favourable prices of American and German steel.

The imports of foreign iron ore at the Prince of Wales Dock, Workington, in August amounted to 24,600 tons, compared with 8,000 tons in July and 7,980 tons in August, 1928. During the month 2,350 tons of pig-iron were shipped to Antwerp, 5,000 tons to Sydney, C.B., and 4,500 tons to home ports; 1,800 tons of steel rails were consigned to London.

Contracts have been placed by the New Zealand Shipping Company for three motor cargo vessels of 9,000 tons each. One is to be built by Messrs. William Beardmore & Company, Limited, one by Messrs. Palmers Shipbuilding and Iron Company, Limited, and the other by Messrs. Vickers-Armstrongs, Limited. Each vessel will have a different type of machinery, namely, Sulzer, Doxford and M.A.N.

An order for a new chain, weighing sixty tons, which is to be used to strengthen the dome of St. Paul's Cathedral, has been placed with Messrs. Brown, Bayley & Company, of Sheffield. Last year the same firm manufactured a stainless-steel chain, weighing thirty tons and 450 ft. in length, which has been used to strengthen the dome. The new chain will take six months to manufacture.

A rudder of the streamline box type was recently fitted to the Ellerman liner "City of Nagpur," at Glasgow, in such a way that the rudder, weighing 18 tons, was shipped into position while the vessel was afloat in Princes Dock. This is the first occasion on which a rudder of this type has been successfully put into position without dry docking the vessel. The work was carried through by Messrs. Cochrane, Morgan & Company, Limited, Govan, Glasgow.

The Greenock Dockyard Company, Limited, have launched the cargo vessel "Barrwhin," built to the order of the Barr Shipping Company, Limited, Glasgow. She is of 9,000 tons deadweight and 405 ft. in length. The machinery to be installed by Messrs. Rankin & Blackmore, Limited, Greenock, consists of triple-expansion engines operating in co-operation with a Bauer-Wach low-pressure turbine, all obtaining steam from three boilers at 200 lbs. pressure.

The prospects for the Wear shipbuilding trade have improved recently. Thirty-three vessels are now on the stocks at the various yards, or nearly twice the number that was being built at the corresponding period of last year. Three, at least, of the yards have orders that will keep them busy well into next year. Two yards only are idle. Last month five vessels, of an aggregate gross tonnage of 21,506, were launched, bringing the total for the year to 29 ships and 119,921 tons.

Considerable interest is being taken in Belfast in the proposal of the Belfast Harbour Commissioners to construct a new dock on the County Antrim side of the harbour, at a cost of £376,000. A section of public opinion considers that the time is inopportune for embarking upon a scheme of this character. It is argued that there is ample accommodation for all present requirements at the harbour, and that the scheme seems to have been put forward solely for the relief of unemployment.

Personal.

Sir Philip Cunliffe-Lister, M.P., who was President of the Board of Trade in the last Government, is to become chairman of the Tin Producers' Association and of the council.

Mr. Richard W. Allen, chairman of Messrs. W. H. Allen, Sons & Company, Limited, Bedford, sailed from Liverpool last week to attend the World Engineering Congress in Tokyo as the delegate of the Universities of Cambridge and London and the Institution of Mechanical Engineers.

Mr. John Rogers, who has held the appointment of Deputy Director of Dockyards since September, 1926, has retired, after more than forty-seven years' service. He has held every post in the constructive department from apprentice up to his present position. Mr. Rogers has been in charge of the building of all types of warships at Royal dockyards and by private firms.

Wills.

Darling, J. W., Keighley, of the firm of Darling & Sellers, Limited, machine-tool makers	£18,566
Potts, J. L., of Sheffield, chairman of Messrs. Jno. Hy. Andrew & Company, Toledo Steelworks	£28,771
Richards, A., of Wednesbury, director of Messrs. Charles Richards & Sons, Limited, Imperial Works, Darlaston, nut and bolt manufacturers	£160,545
Wesson, W., Wolverhampton, founder of W. Wesson & Company, Limited, Victoria Iron and Steel Works, Moxley, Wednesbury	£46,138

Book Review.

Foundrymen's Handbook (second edition). Published by the Penton Publishing Company, Limited, Caxton House, Westminster, London, S.W.1. Price 30s. net.

We have only one or two comments of a critical character to make on this comprehensive compilation and that is its title. Primarily, this new edition possesses 574 pages, and really merits the title of the "Foundrymen's Encyclopædia." Secondly, we are not altogether satisfied with the indexing, but we recognise that a limit must be imposed, otherwise that section would assume alarming proportions.

In this new edition no less than 250 more pages have been included, and we insist that the data contained on these additional pages are well worth the money asked for the whole volume. For instance, a dictionary of technical terms, a vast quantity of typical analyses (mainly for steel-foundry practice), routine analysis and maintenance of equipment have been incorporated. It should be understood that this book includes data for every section of the foundry industry. Naturally, being an American publication, some of the data, such as the section devoted to specifications, have not quite the same direct interest for British users of the book, except for academic and comparative studies.

There is a coloured inset, showing the American Standard Pattern Colours by means of a typical example. We see no reason why this could not be adopted without alteration in other countries and so save much time and trouble of calling together numerous committee meetings, as it is obvious that the matter has been well studied before acceptance.

Czechoslovak Foundry Association.

The Seventh Annual Meeting of the Czechoslovak Foundry Association was held at Prague on September 7 and 8 at the house of the Czechoslovak Engineers S.I.A., Praha II, Dvořákovo nábřeží (near the Svatopluk Čech bridge).

Czechoslovak Foundry Exhibition.

At the 19th Autumn Fair at Praha, Prague, lasting from September 1 to 8, there was organised, with the collaboration of the Czechoslovak Foundry Association, a special Foundry Exhibition, which has created considerable interest not only amongst local firms but also of foreign ones. This is the third foundry exhibition organised by the national foundry association, which indicates that it is keeping well abreast of modern requirements.

The exhibition was situated in the right wing of the Industrial Palace on the Prague Fair ground, and, in addition to exhibitions of raw material, iron, and also auxiliary materials, sand, graphite, fireclay, etc., a large number of moulding and other foundry machinery, mostly operating, was exhibited. Foundry products, such as castings for machinery, chemical, automobile, aeroplane, etc., parts, were shown, made of grey cast iron, as well as of cast steel and hard steel, alloys and aluminium.

Though on a small scale, this exhibition aimed to present as far as possible a complete picture of the nature of the foundry industry and branches relating thereto.

Obituary.

Mr. A. G. Hopper, a former director of Messrs. Greenwood & Batley, Limited, Leeds, died recently.

Mr. T. S. F. Gibson, chief civil engineer of the South Metropolitan Gas Company, died at his home at Blackheath on August 28, aged 59.

Mr. Samuel Machin, under-manager of the Stafford Coal and Iron Company's colliery at Fenton, Stoke-on-Trent, has died at the age of 61 years.

Mr. R. A. Morrison, secretary and a director of Messrs. Stewarts & Lloyds, Limited, Glasgow, has died at the age of 53. He had been connected with the firm for about 25 years.

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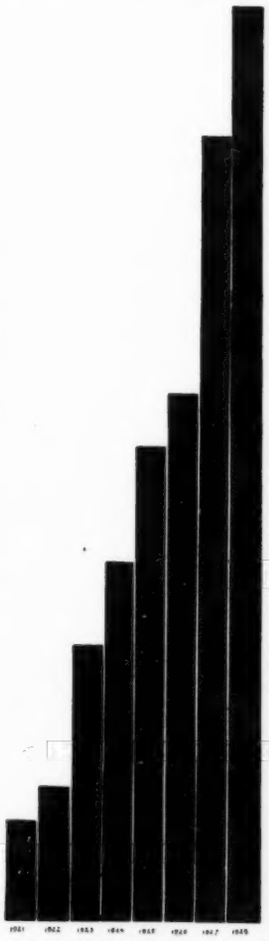

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—As had been fully anticipated, the opening markets of September have already disclosed a revival of interest in Cleveland pig-iron, with a more active tendency on the part of consumers than has been experienced for some time past. At present producers are so well sold that even quite small orders for this month's delivery can only be placed with difficulty, and ironmasters have substantial orders on their books to the end of the year. Notwithstanding the favourable conditions thus outlined, the Cleveland ironmasters are still faced with the difficult problem of achieving a fuller production at the furnaces without greatly enhancing current prices, the cost of raw material in the form of iron ore and fuel, etc., constituting formidable obstacles to progress in this direction. Consumers, therefore, recognising the improbability of a reduction of pig-iron prices in the near future, are buying more freely for autumn deliveries, while even foreign shipments of pig-iron from Tees-side totalled 13,108 tons in August, as against 12,094 in July. Prices meantime remain stationary, as follow:—No. 1 Cleveland foundry iron, 75s. per ton; No. 3 G.M.B., 72s. 6d.; No. 4 foundry, 71s. 6d.; No. 4 forge, 71s. per ton.

Conditions for producers in the East Coast hematite industry are even more difficult than those affecting foundry iron, the sharp advance in fuel costs recently having cut out any possibility of profit for the makers, who protest that a selling price of 80s. per ton would barely cover the works costs, and not improbably the price may have to be advanced to that figure. Sellers are therefore by no means keen on entering into forward contracts at present prices, which are 76s. for mixed numbers and 76s. 6d. for No. 1 quality. On the North-West Coast, Bessemer mixed numbers are unchanged at 75s. per ton at works.

LANCASHIRE.—Expert opinion in local markets for foundry pig is distinctly favourable to an early improvement in business, specifications for new contracts being on an increasing scale. The demand for deliveries is so persistent that, in many instances, producers are meeting with considerable difficulty in coping with them. Prices continue firm, with No. 3 Derbyshire quoted at 74s. 6d., No. 3 Staffordshire at 75s. 6d., and Scotch brands at 93s. 6d., all per ton delivered Manchester or equal.

THE MIDLANDS.—As previously noted, a marked improvement in demand for foundry pig-iron is in evidence in Black Country markets, local consumers now having a fair volume of orders on hand, with a much better outlook than has been the case of late. Prices also are firm, quotations ruling thus:—No. 3 Derbyshire, 76s.; Northants, 72s. 6d., and North Staffordshire 75s., all per ton delivered local stations.

SCOTLAND.—No improvement is reported in the state of the Scotch pig-iron market, although traders are hoping that in the near future there will be a bigger volume of business passing. The price of Scottish iron remains unchanged on the basis of 76s. for No. 3 f.o.t. furnaces, but, as costs are still moving against the makers, the question of a further advance is being keenly debated.

Finished Iron.

Quotations are very steady in this section, although there has been little apparent improvement in the demand. Current offers of Lancashire crown bars are at £10 15s. per ton and of second-quality material at £9 15s. Merchant parcels of the former are maintained on the basis of 14s. 9d. per cwt., less 2½ per cent., and including delivery to buyers' works. South Staffordshire marked bars continue in steady demand, but are unchanged at £12 per ton, with crown qualities at £10 to £10 10s. per ton.

Steel.

Although the full flow of new orders usual in autumn time has hardly materialised as yet, the actual business passing is fairly satisfactory, and at Sheffield the demand for basic billets is maintained, but acid qualities are a very restricted market. There is a good business in wire rods. All prices continue as previously quoted. About three-fifths of the basic steel furnaces in this district are fully engaged, but a considerable number of acid steel furnaces are idle. There is a heavy demand for cold-rolled strip. In the tinplate market there is not much change, and only a moderate volume of business has been done. Owing to the advance in the price of steel, quotations are firmer.

Scrap.

Advices from most of the centres of the scrap trade suggest rather quiet business, and on Tees-side the foundries are still prepared to pay 67s. for small lots of ordinary heavy cast iron. The premium for machinery quality is now no more than 1s. 6d. per ton, the general quotation being 68s. 6d. In Scotland machinery cast-iron scrap suitable for foundries is quoted at 70s., and ordinary heavy cast-iron scrap to the same specification at 63s. 6d. to 65s. Old cast-iron railway chairs remain at 67s. to 68s., with light cast iron at 60s. and firebars at around 57s. 6d. to 58s. 6d. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Following a sharp advance in warrant copper values in mid-week, the market has since slightly reacted, but closed firmly at an advanced price. Consumption, both at home and abroad, is well maintained, and it is expected that the combine will be able to sell freely at present prices, which are very profitable to the producers.

Closing quotations are:—

Cash.—Thursday, £77 17s. 6d. to £78 2s. 6d.; Friday, £76 to £76 5s.; Monday, £76 1s. 3d. to £76 3s. 9d.; Tuesday, £75 12s. 6d. to £75 13s. 9d.; Wednesday, £76 3s. 9d. to £76 6s. 3d.

Three Months.—Thursday, £79 to £79 2s. 6d.; Friday, £77 to £77 2s. 6d.; Monday, £76 17s. 6d. to £77; Tuesday, £76 6s. 3d. to £76 7s. 6d.; Wednesday, £76 12s. 6d. to £76 15s.

Tin.—Adverse opinion on the issue of the monthly statistical returns had a weakening effect upon standard prices, due to the unexpectedly large increase in the visible supply at 25,901 tons. Shipments from the Straits in August were also unusually heavy, as were the increases in Liverpool warehouse stocks. The increase in American consumption for the eight months of the current year is 10,935, and a further substantial increase is expected this month. In addition, the Welsh tinplate industry has experienced a good revival recently.

Official closing prices:—

Cash.—Thursday, £206 15s. to £207; Friday, £205 to £205 5s.; Monday, £205 2s. 6d. to £205 5s.; Tuesday, £204 5s. to £204 7s. 6d.; Wednesday, £204 5s. to £204 10s.

Three Months.—Thursday, £210 15s. to £211; Friday, £209 2s. 6d. to £209 5s.; Monday, £209 2s. 6d. to £209 5s.; Tuesday, £208 7s. 6d. to £208 10s.; Wednesday, £208 5s. to £208 7s. 6d.

Spelter.—This section of the base metal market has been quieter on the whole, although business with consumers has been slightly better, and rather more activity has developed, but demand has been freely met by influential selling and the liquidation of speculative holdings for September, no doubt in anticipation of metal arriving early this month. Messrs. Rudolf Wolff & Company state that advices from the Continent are none too favourable, reports from industrial centres there indicating a slackening of demand.

Daily quotations are:—

Ordinary.—Thursday, £24 16s. 3d.; Friday, £24 15s.; Monday, £24 10s.; Tuesday, £24 7s. 6d.; Wednesday, £24 7s. 6d.

Lead.—Prices of soft foreign pig have fluctuated within narrow limits, but registered an increase at the close. The formation of the Lead Producers' Association seems to have stimulated the market, and though business has been largely professional, active conditions have at times prevailed. Demand has, however, been freely met by interests representing the Association.

Prices have been:—

Soft Foreign Prompt.—Thursday, £23 12s. 6d.; Friday, £23 12s. 6d.; Monday, £23 11s. 3d.; Tuesday £23 7s. 6d.; Wednesday, £23 8s. 9d.

Sponge Iron.

In the course of a Paper read before the American Electro-Chemical Society recently by Mr. N. K. G. Tholand on "Sponge Iron," the author said that various ores have been reduced at Hoeganaes, in Sweden, on an industrial scale, and, in general, it may be said that by the Hoeganaes process every known ore can be reduced. The richer the ore, however, the more complete is the reduction. Ores containing more than 60 per cent. total iron are the most suitable. The reduction, however, is largely dependent upon the composition of the ore and of the gangue, and it is, therefore, not always possible to know within what range economic reduction is possible. A pure magnetic plus silica ore is more easily reduced than another ore of the same total iron content, but containing iron silicates, which have been found difficult to reduce. It is interesting to record in this connection that hematites are likewise easily reducible as compared with magnetites.

Phosphorus Content.

Phosphorus minerals in the ores will probably in all cases remain unreduced, and are usually so intimately mixed with the iron, that in no case on record has it been possible to lower appreciably the final phosphorus content of the sponge iron.

A sponge iron produced from a high-grade magnetite and silica ore, well reduced but with a certain amount of still unreduced-iron oxides, would seem to be of more value to the steel-maker than a sponge iron equally well reduced but containing some unreduced iron silicates. The production of a partly-reduced sponge iron, high in gangue, has deliberately been considered on account of the well-known difficulties of complete reduction and concentration. Such a product would be utilised by duplex or triplex steel processes, by melting and tapping from an acid-electric furnace with one or two refining periods in a basic-electric or open-hearth furnace. Such a sponge iron, of course, must be considered and valued on other grounds than well reduced, high-grade sponge iron, which can be made directly into steel.

The markets for special steels demand quality, and it may be safe to predict that the specifications of physical properties will not become easier, but more and more difficult to meet.

The maker of high-grade steel has thus a promising prospect for a pure iron at a reasonable cost, and sponge iron, properly made from a suitable ore, is very suitable. It has the advantage over pig-iron that it can be made with almost any carbon content desired. The sponge iron producers and users, however, claim a justification for the demand of the material other than from an analytical viewpoint. Claims are made that steels made with sponge iron show superior physical qualities. There is ample evidence to support such claims in specific cases and for specific purposes. There is also evidence that the experiences in such cases may be generalised, and that it might be desirable to base steel manufacture more generally upon sponge iron rather than upon other materials.

It must be remembered, states the author, that sponge iron, properly made from a suitable ore, undoubtedly contains fewer impurities combined with iron than any other melting base. In pig-iron, on the other hand, all impurities are necessarily more or less combined with the iron, and the same thing, of course, is true of scrap and other materials used as a base for steel-making, and which originated from pig-iron. The influence on the ultimate quality of fine steels, by non-metallic inclusions and of dissolved oxides, is stressed to-day more than ever. Hoeganaes sponge iron is produced from purest Swedish magnetite, from the large ore deposits in the northern part of Sweden. The ore is very high in iron, and the gangue consists mostly of silica.

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COPPER.

	£	s.	d.
Standard cash	76	3	9
Three months	76	12	6
Electrolytic	84	10	0
Tough	79	10	0
Best selected	80	0	0
Sheets	110	0	0
India	96	10	0
Wire bars	84	12	6
Do. Oct.	84	12	6
Do. Nov.	84	12	6
Ingot bars	—		
H.C. wire rods	86	15	0
Off. av. cash, August	73	16	8 5/7
Do. 3 mths., August	74	12	2 3/7
Do., Sttlmnt., August	73	16	3 3/7
Do., Electro, August	84	10	0
Do., B.S., August	78	5	10
Aver. spot price, copper, Aug.	73	16	8 5/7
Do. wire bars, August	84	15	0
Solid drawn tubes			15d.
Brazed tubes			15d.
Wire			11½d.

BRASS.

Solid drawn tubes	12¾d.
Brazed tubes	14¾d.
Rods, drawn	12½d.
Rods, extd. or rlld.	8d.
Sheets to 10 w.g.	11¾d.
Wire	11½d.
Rolled metal	10¾d.
Yellow metal rods	8d.
Do. 4 × 4 Squares	8½d.
Do. 4 × 3 Sheets	9d.

TIN.

	£	s.	d.
Standard cash	204	5	0
Three months	208	5	0
English	204	10	0
Bars	206	10	0
Straits	208	5	0
Australian	206	10	0
Eastern	213	5	0
Banca	216	5	0
Off. av. cash, August	209	17	11 5/7
Do., 3 mths., August	213	17	6
Do., Sttlmt., August	209	17	7 3/7
Aver. spot, August	209	17	11 5/7

SPELTER.

Ordinary	24	7	6
Remelted	22	10	0
Hard	20	15	0
Electro 99.9	26	10	0
English	25	0	0
India	21	10	0
Zinc dust (Nom.)	34	10	0
Zinc ashes	8	15	0
Off. aver., August	25	0	7½
Aver., spot, August	24	17	11

LEAD.

Soft foreign ppt.	23	8	9
English	24	15	0
Off. average, August	23	4	5 3/14
Average spot, August	23	3	8 3/7

ZINC SHEETS, &c.

Zinc sheets, English	34	10	0
Do. V.M. ex-whf.	32	12	6
Rods	40	0	0
Boiler plates	30	10	0
Battery plates	31	0	0

ANTIMONY.

Special brands, Eng.	50	5	0
Chinese	32	0	0
Crude	Nominal		

QUICKSILVER.

Quicksilver	22	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—			
25%	7	15	0
45/50%	12	0	0
75%	19	10	0
Ferro-vanadium—			
35/50%	12/10 lb. Va.		
Ferro-molybdenum—			
70/75% c. free	4/- lb. Mo.		
Ferro-titanium—			
23/25% carbonless	11d. lb.		
Ferro-phosphorus, 20/25%	£16	0	0
Ferro-tungsten—			
80/85%, c. fr.	3/3½ lb.		
Tungsten metal powder—			
98/99%	3/6½ lb.		
Ferro-chrome—			
2/4% car.	£32	10	0
4/6% car.	£23	7	0
6/8% car.	£22	10	0
8/10% car.	£22	0	0
Ferro-chrome—			
Max. 2% car.	£33	0	0
Max. 1% car.	£37	12	6
Max. 0·70% car.	£40	0	0
70%, carbonless	1/2 lb.		
Nickel—99% cubes, or pellets	£175	0	0
Ferro-cobalt	9/4 lb.		
Aluminium 98/99%	£95	0	0
Metallic chromium—			
96/98%	2/6 lb.		
Ferro-manganese (net)—			
76/80% loose	£13	15	0
76/80% packed	£14	15	0
76/80%, export	£14	0	0
Metallic manganese—			
94/96%, carbonless	1/6 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finshed bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	3	15	0	to	3	16	0
Bundled steel and shrngs.	3	12	0	to	3	15	0
Mixed iron and steel	3	10	0	to	3	11	0
Heavy cast iron	2	17	6	to	3	0	0
Good machinery for foundries	3	0	0	to	3	2	6
Cleveland—							
Heavy steel					3	5	0
Steel turnings					2	17	6
Cast iron borings					2	15	0
Heavy forge					3	17	6
W.I. piling scrap					3	11	6
Cast-iron scrap	3	7	0	to	3	8	6
Lancashire—							
Cast-iron scrap	3	2	6	to	3	10	0
Hvy. wrought					3	17	6
Steel turnings					3	0	0
Scotland—							
Heavy steel					3	17	6
Cast-iron borings					2	15	0
Wrought-iron piling					3	17	6
Heavy machinery					3	10	0

London—Merchants' buying prices delivered yard.

Copper (clean)	68	0	0
Brass	44	0	0
Lead (less usual draft)	21	5	0
Tea lead	17	0	0
Zinc	16	10	0
New aluminium cuttings	68	0	0
Braziery copper	60	0	0
Gunmetal	60	0	0
Hollow pewter	150	0	0
Shaped black pewter	106	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	75/-
Foundry No. 3	72/6
Foundry No. 4	71/6
Forge No. 4	71/-
Hematite No. 1	76/6
Hematite M/Nos.	76/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/-
„ d/d Birm.	92/-
Midlands—	
Staffs. common*	—
„ No. 4 forge*	73/-
„ No. 3 fdry*	77/-
Shrops. basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	68/6
„ fdry. No. 3*	72/6
Derbyshire forge*	72/-
„ fdry. No. 3*	76/-
„ basic*	—

* d/d Black Country dist.

Scotland—	
Foundry No. 1	78/6
„ No. 3	76/-
Hem. M/Nos.	80/-
Sheffield (d/d district)—	
Derby forge	67/-
„ fdry. No. 3	71/-
Lincs. forge	—
„ fdry. No. 3	74/6
E.C. hematite	87/-
W.C. hematite	87/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
„ fdry. No. 3	74/6
Northants foundry No. 3	—
Dalzell, No 3 (special)	102/6 to 105/-
Summerlee, No. 3	93/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	93/-
Monkland, No. 3	93/-
Shotts, No. 3	93/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.) nom.					10	15	0
Nut and bolt iron	9	0	0	to	9	5	0
Hoops	11	0	0	to	11	10	0
Marked bars (Staffs) f.o.t.					12	0	0
Gas strip	11	0	0	to	11	10	0
Bolts and nuts, ¾ in. × 4 in.					15	5	0
Steel—							
Ship plates	8	12	6	to	8	17	6
Boiler plts.	9	12	6	to	10	10	0
Chequer plts.					10	12	6
Angles					8	2	6
Tees					9	2	6
Joists					8	2	6
Rounds and squares, 3 in. to 5½ in.					9	2	6
Rounds under 3 in. to ¾ in. (Untested)					8	0	0
					and upwards		
Flats, over 5 in. wide and up					8	7	6
Flats, 5 in. to 1½ in.					7	17	6
Rails, heavy					8	10	0
Fishplates					12	10	0
Hoops (Staffs)					10	0	0
Black sheets, 24g.	10	5	0	to	10	10	0
Galv.cor.shts., 24g.	13	5	0	to	13	10	0
Galv. fencing wire 8g. plain					12	0	0
Billets, soft	6	7	6	to	6	15	0
Billets, hard	7	10	0	to	8	0	0
Sheet bars					6	5	0
Tin bars					6	5	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/4
Sheet to 10 w.g.	1/5
Wire	1/6½
Rods	1/5
Tubes	1/9½
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bessemer billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.95
Tank plates	1.95
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.50
Sheets, blue an'l'd, No. 13	2.35
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplates, 100 lb. box	$5.35

COKE (at ovens).

Welsh foundry	24/- to 27/6
„ furnace	21/- to 24/-
Durham and North.	
„ foundry	22 6
„ furnace	20/6 to 21/6
Midlands, foundry	—
„ furnace	21/6 and up

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box		18/6
„	28×20 „		37/-
„	20×10 „		26/9
„	18¾×14 „		19/6
C.W.	20×14 „		15/3
„	28×20 „		33/6
„	20×10 „		22/6
„	18¾×14 „		16/-
Terneplates	28×20		33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	15	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods, dead soft, steel	£10	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ½ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	65%	47½%
Water	61½%	42½%
Steam	57½%	37½%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Sept. 5 ..	77	17	6	dec.	20/–
„ 6 ..	76	0	0	„	27/6
„ 9 ..	76	1	3	inc.	1/3
„ 10 ..	75	12	6	dec.	8/9
„ 11 ..	76	3	9	inc.	11/3

Electrolytic Copper.

		£	s.	d.		
Sept. 5 ..	84	10	0	dec.	2/6
„ 6 ..	84	10	0	No change	
„ 9 ..	84	10	0	„	„
„ 10 ..	84	10	0	„	„
„ 11 ..	84	10	0	„	„

Standard Tin (cash).

		£	s.	d.		
Sept. 5 ..	206	15	0	inc.	15/–
„ 6 ..	205	0	0	dec.	35/–
„ 9 ..	205	2	6	inc.	2/6
„ 10 ..	204	5	0	dec.	17/6
„ 11 ..	204	5	0	No change	

Tin (English ingots).

		£	s.	d.		
Sept. 5 ..	207	0	0	No change	
„ 6 ..	205	5	0	dec.	35/–
„ 9 ..	205	7	6	inc.	2/6
„ 10 ..	204	10	0	dec.	17/6
„ 11 ..	204	10	0	No change	

Zinc Sheets (English).

		£	s.	d.		
Sept. 5 ..	34	10	0	No change	
„ 6 ..	34	10	0	„	„
„ 9 ..	34	10	0	„	„
„ 10 ..	34	10	0	„	„
„ 11 ..	34	10	0	„	„

Spelter (ordinary).

		£	s.	d.		
Sept. 5 ..	24	16	3	inc.	7/6
„ 6 ..	24	15	0	dec.	1/3
„ 9 ..	24	10	0	„	5/–
„ 10 ..	24	7	6	„	2/6
„ 11 ..	24	7	6	No change	

Lead (English).

		£	s.	d.		
Sept. 5 ..	25	0	0	No change	
„ 6 ..	25	0	0	„	„
„ 9 ..	25	0	0	„	„
„ 10 ..	24	15	0	dec.	15/–
„ 11 ..	24	15	0	No change	

AVERAGE MONTHLY PRICES OF FURNACE COKE D/D MIDDLESBROUGH.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1895	0 12 3	0 12 3	0 12 3	0 12 3	0 12 3	0 12 3	0 12 3	0 12 3	0 12 6	0 13 3	0 13 3	0 13 3	0 12 5½
1896	0 13 0	0 13 0	0 13 6	0 13 6	0 13 6	0 13 9	0 13 6	0 13 3	0 13 3	0 13 3	0 13 6	0 13 6	0 13 4½
1897	0 13 6	0 13 6	0 13 6	0 13 3	0 13 3	0 13 6	0 13 6	0 13 6	0 13 3	0 13 3	0 13 0	0 13 6	0 13 4½
1898	0 13 6	0 13 6	0 15 0	0 13 6	0 13 9	0 14 0	0 14 3	0 14 3	0 14 6	0 14 9	0 15 0	0 15 6	0 14 3½
1899	0 15 6	0 15 6	0 16 0	0 16 3	1 0 0	1 1 0	1 1 6	1 1 6	1 1 6	1 1 0	1 2 0	1 5 0	0 19 8½
1900	1 5 0	1 5 6	1 6 6	1 8 0	1 8 6	1 9 0	1 9 0	1 8 0	1 8 0	1 7 0	1 3 0	0 19 0	1 6 4½
1901	0 17 6	0 14 0	0 13 0	0 14 0	0 14 6	0 15 0	0 15 3	0 15 3	0 15 9	0 16 6	0 16 9	0 16 9	0 16 4½
1902	0 16 9	0 15 0	0 15 0	0 15 0	0 15 0	0 15 3	0 15 3	0 15 3	0 15 6	0 16 0	0 16 6	0 16 0	0 15 5
1903	0 15 9	0 16 0	0 16 3	0 16 9	0 16 6	0 16 3	0 16 0	0 15 9	0 15 6	0 15 0	0 14 6	0 14 0	0 15 8½
1904	0 13 9	0 13 9	0 13 3	0 14 3	0 14 6	0 14 3	0 14 3	0 14 3	0 14 3	0 14 0	0 14 0	0 14 6	0 14 1½
1905	0 14 9	0 15 3	0 15 3	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 9	0 17 0	0 15 5½
1906	0 17 6	0 17 6	0 17 0	0 17 0	0 17 0	0 16 6	0 17 0	0 17 0	0 18 3	0 18 6	0 19 0	1 0 0	0 17 8½
1907	1 4 6	1 5 0	1 5 0	1 0 6	1 2 0	1 1 0	1 1 0	1 1 0	1 2 0	1 1 6	1 0 0	0 17 0	1 1 8½
1908	0 16 0	0 16 0	0 15 6	0 16 0	0 16 3	0 16 0	0 15 6	0 15 6	0 15 6	0 15 3	0 16 0	0 16 0	0 15 9½
1909	0 16 0	0 15 3	0 15 0	0 14 9	0 15 6	0 15 9	0 15 6	0 15 6	0 16 6	0 17 0	0 17 6	0 17 0	0 15 1½
1910	0 18 4½	0 18 6½	0 18 0	0 18 0	0 17 10½	0 17 0	0 16 1½	0 15 9½	0 15 11	0 16 0	0 15 9½	0 15 8	0 16 1
1911	0 16 0	0 15 10½	0 15 6	0 15 3	0 14 9	0 14 6	0 14 6	0 14 6	0 14 6	0 14 11½	0 15 0½	0 16 3½	0 15 1½
1912	0 17 3	0 17 3	0 18 6	0 18 10	0 19 0	0 19 4½	0 19 10½	1 0 9½	1 2 9	1 4 1½	1 5 8½	1 8 6	1 1 0
1913	1 5 9	1 4 11	1 5 0	1 5 0	1 4 9½	1 0 4½	0 19 5½	0 18 3	0 18 0	0 18 2½	0 18 6	0 18 6	1 1 4½
1914	0 18 2	0 17 1	0 17 0	0 17 0	0 17 4	0 17 6	0 17 6	0 18 5	0 18 4	0 17 9	0 17 6	0 18 5	0 17 8
1915	0 17 10½	0 17 9	1 0 4½	1 7 7½	1 9 4½	1 10 7½	1 9 7	1 7 3	1 5 4	1 4 9	1 9 6	1 13 0	1 6 1
1916	1 10 9	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6½
1917	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 14 3	1 15 6	1 11 2½
1918	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6
1919	1 15 6	1 15 6	1 15 6	1 15 6	2 1 6	2 1 6	2 3 9	2 10 6	2 10 6	2 10 6	2 10 6	2 10 6	2 3 5
1920	2 12 3	2 14 0	2 19 0	2 19 0	3 3 8	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 2 6
1921	3 1 0½	2 19 0	2 16 0	2 7 0	2 6 6	2 6 6	2 0 6	2 0 0	1 13 11	1 12 9	1 10 4½	1 8 3	2 3 6½
1922	1 7 0½	1 8 1½	1 9 7½	1 8 4½	1 7 11½	1 7 3	1 6 9½	1 6 10½	1 7 0½	1 10 2½	1 10 0	1 9 11½	1 8 3½
1923	1 11 3	1 14 6	2 0 1½	2 2 8½	2 4 4½	2 2 10½	2 1 0½	2 1 6	2 0 9½	1 18 9	1 18 8½	1 18 3	1 19 7½
1924	1 16 6½	1 14 9	1 11 11½	1 10 0½	1 8 1½	1 7 8½	1 7 3	1 6 3	1 6 0	1 5 0	1 5 0	1 5 0	1 9 5½
1925	1 4 10½	1 4 1½	1 13 3	1 2 4½	1 2 2½	1 1 5½	1 1 3½	1 4 9	0 18 10½	0 18 4½	0 19 6½	1 1 4½	1 2 8½
													(5 months)
1926	1 2 1½	1 0 9	0 19 2½	0 18 6½	Strike	Strike	Strike	Strike	Strike	Strike	Strike	1 5 0	1 1 1½
1927	1 5 6	1 4 9½	1 6 1½	1 3 9	1 2 6	1 0 8½	0 19 4½	0 19 0	0 18 7½	0 18 0	0 17 10½	0 17 6	1 1 1½
1928	0 17 6	0 17 10½	0 18 0½	0 17 11½	0 17 8½	0 17 6½	0 17 7½	0 17 6½	0 17 6	0 17 7½	0 17 7½	0 17 6	0 17 8
1929	0 17 7½	0 18 0	0 19 0	0 19 6½	0 18 10½	0 19 10½	1 1 3½	1 1 8½	—	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARK

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

TO PRINCIPALS, Etc.—Advertiser, well known to and in constant personal touch with principal ironfounders, iron and steel manufacturers, the majority of works in Black Country, Birmingham, and Midland districts, seeks opening, in outside capacity, for younger brother (25), with good selling experience, smart appearance, and own car.—Box 316, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY MANAGER seeks position; thoroughly practical in all branches; good references; replies confidential.—Box 312, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

YOUNG NON-FERROUS FOUNDER, practical, studious, nearly nine years' jobbing foundry experience, seeks position of trust, progressive, home or abroad.—Box 310, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Foundry Foreman, production large high-class turbine and electrical work, responsible for iron mixtures; efficient organiser for maximum output. State age, experience, references, and salary expected.—Box 314, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY FOREMAN wanted for general engineering and jobbing foundry in South Wales; must be accustomed to best machinery castings in iron and brass, and able to deal with urgent jobs.—Apply, with copies of recent testimonials, Box 318, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY.

SAND MIXERS.—New and Secondhand. Ask us to quote.—W. BREALEY & COMPANY, LIMITED, Prospect Works, Hawksley Avenue, Sheffield.

No. 100 LUMSDEN Surface Grinding Machine, with planetary head, grinding capacity 24 in. dia.

PRATT & WHITNEY, Automatic Grinder, for thread milling cutters.

UNGER 8-in. x 32-in. Universal Grinding Machine, with internal attachment.

10-in. x 10-ft. LOEWE Plain Cylindrical Grinder.

Four "SMITH" LOCO. STEAM CRANES, 22-ft. 6-in. steel jibs; 4 ft. 8½ in. gauge; vertical boiler, 80 lbs. w.p.

5-ton "WILSON" ALL-STEEL STEAM TRAVELLING DERRICK CRANE, 50-ft. jib; vertical boiler, 80 lbs. w.p.

Two Dish-ended LANCASHIRE BOILERS by Thompson, 30 ft. 0 in. x 8 ft. 0 in., re-insure for 150 lbs. per sq. in. w.p.

SEVERAL HUNDREDS OF TANKS, rectangular and circular, 10 galls. capacity upwards.

Several practically new high-pressure STORAGE VESSELS, about 18 ft. long x 4 ft. dia., insurable working pressure 625 lbs. per sq. in.

Chain Rail Tractor (Clayton), 35 h.p., 4-cylinder Dorman Engine; type 4JO. Overall dimensions 9 ft. 6 in. long x 5 ft. 6 in. wide x 6 ft. 3 in. high; creepers 14 in. wide; petrol-paraffin drive.

(ASK FOR "ALBION" MACHINERY CATALOGUE.)

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

NOTICES.

CITY OF LONDON.

THE SIR JOHN CASS TECHNICAL INSTITUTE.
Jewry Street, Aldgate, E.C.3.

Principal:
GEO. PATCHIN, A.R.S.M., M.Inst.M.M.

DEPARTMENT OF METALLURGY.

The following special course of instruction will be given during the 1st and 2nd Terms (September to April) of the Session 1929-30, commencing Monday, September 23, at 7 p.m.

FOUNDRY PRACTICE.

By L. SINGLEHURST WARD, B.Sc., and A. F. GIBBS.

The course, which will consist of lectures, demonstrations and practical work in moulding and casting, is arranged for metallurgists and those engaged in Engineering and Foundry Work and will be of value to those interested in the production of all classes of castings.

Full particulars of the above course and also of the general courses given in the Department of Metallurgy may be obtained upon application to the Principal.

BOROUGH POLYTECHNIC INSTITUTE,
Borough Road, London, S.E.1.

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Evening Classes and Grouped Courses of Instruction are specially arranged for Apprentices, Improvers and Craftsmen in the Foundry Trade, the following subjects being included:—Foundry Practice, Workshop Processes, Metallurgy, Technical Drawing, Practical Mathematics, Engineering Science, Mechanics of Foundry Equipment, Chemistry of Metals, Foundry Management and Costs.

Enrolment, September 16, 18 and 20, 1929, 7 to 9 p.m.

Sessional Fees to London and Kent Students:
Grouped Course, 30s.
Single Subjects, 20s.

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Prospectus will be forwarded on application.

J. W. BISPHAM,
Principal.

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145,000 Sq. Ft. of SHOPPING,
Compact and Convenient.
SIDING CONNECTIONS
with L.M. & S. and L. & N.E. Rlys.
WELL-BUILT & COMMODIOUS OFFICES
Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

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